THE

Practical Teacher

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Edited by JOSEPH HUGHES.

'Knowledge is proud that he has learned so much,
Wisdom is humble that he knows no more.'—COWPER.

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Hygiene.

BY ALFRED CARPENTER, M.D., M.R.C.P. (LOND.).

HOW TO PREVENT DISEASE IN SCHOOL AND HOME.

As to Nurses and Nursing (continued).—There is an idea among a certain class of persons that nursing in the abstract is an occupation which should be carried on quite independently of the feelings of the patients, and that their wishes are not to be thought of in regard to the personal service of the nurse. Proposals have been made by nursing sisterhoods to nurse certain hospitals, which proposals have been accepted by the managers, but the result has been disagreement between the nursing staff and the doctors. The Superior has claimed the right to change the nurse whenever it seemed good for her to do so, without the concurrence of the medical man. This plan is most objectionable, it is certain at times to be highly injurious to the patient, and to militate against the cure. Abstractedly one nurse may be as good as another, but it does not follow that she is as good for that case. A nurse is, or should be, an artist. She has become acquainted with the peculiarities of her case. If a surgical one she has obtained a certain kind of dexterity from experience in its behaviour, which is advantageous to the patient. We might just as well change the doctor in the middle of the treatment of an acute case of disease, or the portrait painter when the likeness is half finished, or a commander when a fight is raging. It is a bad principle in the minor question of nursing, as well as in the major cases, and should never be done without the concurrence of the doctor himself. It may be advantageous to the Society of Nurses that they should have the opportunities of nursing acute cases multiplied among themselves by several nurses having the opportunity of nursing one case; but it is not advantageous to the patient, and that should be really our first consideration. The nurse must not be changed therefore without the concurrence of the doctor. Indeed, the care of the case must not be taken out of the doctor's hands, though it would be always best in a large hospital, or in sick wards, that the management of the nurses, as regards all other details, should be in the hands of the matron or sister superior.

Nurses must be trained for their work. It is very distressing sometimes to see how life is lost, notwithstanding the skill of the doctor, for want of an acquaintance with the first principles of nursing by those who are undertaking that duty. Nursing among different classes in society is also different, the arrangements which are satisfactory in one home will not be so in another, and that which is possible in a rich man's house, cannot be entertained in the cottages of the poor; and yet nurses for the poor should be trained also. The mischief which is done in workhouse infirmaries by using pauper inmates as nurses, so that the rates may not be burthened, is a crying evil, many a poor person is rendered a permanent invalid, and made to be a permanent charge upon the poor rate, because there was not a trained nurse to take care of the case when it especially required it, and medical officers of the workhouse infirmaries are often helpless in the matter. Fortunately for humanity people are becoming aware of this evil, and nursing establishments are being multiplied in which training is a 'sine quâ non' before employment can be obtained. The Nightingale Home at St. Thomas's Hospital is one in which a year is devoted to training. Three years are then taken up by the employment of the new comers as nurses in that hospital, at the end of that time they are fit for any post. They are styled probationers in the first year, and they are under the authority of the matron, and subject to the rules of the hospital, and serve as assistant nurses, receiving from time to time instruction from the sister and the medical instructor, who gives lectures somewhat more advanced than those which are now given in many places to ambulance classes. These latter are useful means by which nurses may be trained in country places, especially in those in which a cottage hospital has been established. The classes should never be left in abeyance, but worked in connection with the staff of the hospital. Nurses should always be treated as trusted upper servants in private houses, and not be expected to fulfil duties which do not belong to them. When required to sit up at night, the nurse should retire to rest for seven hours during the day,

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out of the sick room; and, in addition, at least one hour must be allowed for exercise in the open air. If she sleeps in the patient's room, she should have a separate bed. When she has the opportunity, she should sleep in a quiet room by herself. Her meals should not be taken in the sick room, and when on night duty there should be proper extras, such as tea, coffee, and cocoa, with some animal food, but no night nurse will be certain to do her duty properly if she allows herself to take intoxicating liquors; the use of these tend to all kinds of irregularities, they promote sleep at wrong periods, and if there be any hidden tendency to hysteria in the nurse, stimulants will bring it out, and render her utterly unfit to do her duty, for no hysterical person is fit to be a nurse under any circumstances whatever, if there is likely to be any strain upon the system. Many ladies are taking up nursing, not so much as a means of livelihood as of occupation. It is an advantage to have a highly educated and refined woman in the sick room, but it is not always wise that the fact that she is a lady born should be known to those employing her. The moral influence which such a woman is sure to obtain is the true information for her employers, and when a lady nurse presumes upon the fact of being a lady, the nursing will not always be done to the satisfaction of the doctors, or lead to the patient's more rapid recovery. A true lady will make the best nurse if she forgets her origin, and does her duty thoroughly; if she has been well trained she will be of the greatest help to the doctor, she may be his superior even in nursing knowledge, but, whilst using it properly, she will fail if she attempts to show it to the doctor's disadvantage. A nurse must never be above her work, or forget that the doctor is her superior officer. The nurse should be careful to avoid giving advice to the sick, as Miss Nightingale has so well said 'Chattering hopes' are their bane. A nurse will do best who keeps her patients from talking about their ailments, or of talking of others having similar diseases. The absurd consolations which are sometimes offered to the sick, the statistical comparisons which are frequently made for no good purpose, all tend to do injury, and cannot produce benefit. A gossiping nurse is a great evil. She had much better advise the patient to write down the various prescriptions which may be given to him by different friends, and so show the utter absurdity of such gratuitous advice, in consequence of their antagonisms one to another, than to allow him to be thinking about them and making out that the advice is something which he ought to follow. The wonderful prescriptions of the advisers of the sick are no novelties, they were the same a thousand years ago, and will be as long as nervous people last. The daily and local penny press is filled with the wonderful cures performed by quacks, all of which are utterly false as to "post hoc ergo propter hoc,' and a nurse who does her duty, will avoid chatterings about such things, and discountenance presumptious advice. The dress of the nurse is of some importance, it should be quite plain, and made of washable material. The dress of the sisters of some of the religious sisterhoods is highly objectionable, its only use is to save them from insult among the lowest of the low. That adopted by the St. John's Home, Norfolk-street, or the Devonshire-square Sisters, is much more in accord with the necessities of the office, and is in every way most satisfactory. Nurses must be clean in their own persons. A nurse must have a singleness in her aim, thoroughness in the execution of her work, and simplicity in her whole character, so that she may do her work with fervour and zeal as unto a higher power than man's, and with the true desire to soothe and be a comfort to the dying as well as to rejoice with those who recover.

Ambulance Classes.—Every nurse should have had the training which ambulance classes afford, and, thanks to the St. John's Ambulance Association, these classes may be formed anywhere, and instruction given by qualified men. Mr. John Furley, the deputy chairman of the association, has been indefatigable in promoting this work. The course of instruction is simple, and may be understood by the most moderate intellect. Every large advanced school should have such a course of instruction at regular intervals, either in connection with the classes belonging to the locality, or within its own borders. Children cannot be taught too early what to do in emergencies. The work of an ambulance class is to teach people what to do in cases of sudden illness or sudden accident before the doctor arrives; to teach women how to co-operate with the doctor, in the sick room. Ambulance work is to aid the doctor and the nurse by teaching some of the first principles of common sense to all people. First aid to the wounded may be the means of saving countless lives in the course of a generation. Instincts in accident or injury are not always safe to follow, and very few people who have not been instructed can properly bandage a wounded limb, or know whether to let an injured man sit upright or keep him in a strictly recumbent position. Every schoolmaster should consider it a part of his duty to have such instruction afforded; as a rule, his medical adviser will probably be willing to give the instruction, or to put him in the way of obtaining it from one of his less occupied medical friends. The unwisdom of raising a fallen man, with possibly a broken leg, will be shown, and the plan which should be adopted in such cases pointed out, whilst the method of carrying a damaged person must depend upon the nature of the damage, and can only be shown by example and actual experience in the use of the means.

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This arrangement should not be lost sight of by the managers of elementary schools, whenever infectious disease shows itself among the children. The sooner a case is removed to a proper hospital so much the better for both the patient and the neighbourhood, and no sentiment should, if possible, be allowed to

impede the removal. In this action a schoolmaster has sometimes opportunity to wisely advise the parents of children who may be suffering from infectious disease. He will be able to point out to them the dangers of delay in treatment, as far as the child is concerned, whilst the advantage to the school itself is manifest.

Disinfecting Chambers.—Every infectious hospital or ward should have a disinfecting chamber attached to it in which all clothing apparel and other unwashable materials may be disinfected. The best method is by steam heat, or dry heat, according to the nature of the infected article. There are various kinds of apparatus, the best are shown at the annual exhibitions of the Sanitary Institute of Great Britain, and are such as Lyon's disinfector, and Dr. Scott's disinfecting apparatus. Both have been certificated as fully competent to do the work they undertake to perform, but they require an intelligent supervision, which can be obtained by practice alone, and disinfection cannot be carried out by an ignorant and unskilled person. Every sanitary authority should have a disinfecting chamber, even if there are not infectious wards. It would be an immense comfort to large elementary schools if there could be attached to the school a hot air chamber, in which the clothes of the children could be rapidly dried on wet days, the ova of living creatures and the germs of infectious disease being destroyed at the same time. It would be a great saving to the State in the long run, though the expenditure on capital account and the annual cost of working would add something to the first cost of education. A drying closet attached to the heating apparatus would not be a very large item. The comfort to the children, the advantage to the health, and the safety to all concerned, would be much added to. I introduced this proposal to the Social Science Association at its Glasgow meeting, but economists did not view it with favour. No one accustomed to enjoy fresh air can fail to be aware of the noisome nature of the atmosphere of a school on a wet day, an hour after its assembly. The reeking clothes of the children destroy the healthiness of the place, ventilate as much as you like, it is impossible to get rid of the whole of the evil, but if the boys could have their coats removed for a few minutes, and have them placed in a drying closet, it would be an immense boon to the masters as well as to the children themselves. I press its necessity upon the School Boards of the country as still one of the things needful to be done. Dry clothes would also assist to prevent much illness, besides diminishing the incidence of infectious diseases, and be destructive to parasitic life among the children of the poor. The temperature in the disinfecting chamber and the drying closet must exceed 220° F. to be effectual.

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CHAPTER VI.

ANDROMEDA [PERSEUS].

ANDVARI, in Teutonic mythology, is the dwarf who guards the golden treasures of the dawn maiden Brynhild, which, during the winter season, are hoarded in stony caves with ice-like walls. The theft or the hoarding of treasure is one of the most prominent incidents in the popular stories of all lands. The treasures always belong to a bright and beautiful maiden, who is stolen with them, or imprisoned within barriers which none can pass until the hero comes who is destined to deliver her. This deliverance is always accomplished, and the recovery of the treasures goes along with it. It must not be forgotten that in the 'Iliad' the robbery of Helen's treasures is a matter of as much importance as the seduction of Helen herself, if not of more; and the loss of the golden hoard of Siegfried, in the 'Nibelungenlied,' is the cause of the great catastrophe described at the end of the poem. The treasure thus stolen is either the light of the day or the warmth of the summer. In other words, these stories belong to myths or legends which relate to the alternation of day or night or the succession of the seasons. In the Volsung story, the tale relates to the killing of the summer by the winter; and Andvari represents the winter cold, which guards the wealth of Brynhild, who lies within the coils of the great dragon of the Glistening Heath. When the time of her re-awakening draws nigh, Odin sends Loki to the dwelling of the dark elves, where he compels Andvari to surrender these treasures. But there is one ring which Andvari seeks especially to keep; that is, he wishes to withhold the summer itself as represented by the symbol of the reproductive power in nature. We have already seen this ring or circle in the necklace or ring of Harmonia [AMPHIARAOS], and we shall meet with it again and again in the myths or stories of Aphroditê, Athêne, Isis, and many more. In the Nibelung Lay, the place of Andvari is filled by the dwarf Alberich.

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of a child's birth becomes its mystagogue, or guide through the mysterious journey of life. In the Latin it is the Genius, whose own life comes to an end with that of the human being whom it guards. This notion is found also in the idea of the Hamadryads, or nymphs attached to trees, whose destruction involves their own. The office of guardian angel is also performed by the goddess Tychê, whose name denotes strictly mere 'chance'; but with the epithet Agathê, *good*, she becomes practically identical with the Agathos Daimon, the nameless benignant deity invoked by cities and by individual men. This guardian was invoked on all occasions in such forms as our 'Luck be with you.'

ANGROMAINYUS [AHRIMAN.]

ANNA PERENNA. In the 'Æneid,' Virgil assigns to Dido, the queen of Carthage, a sister Anna, whom Latin tradition identified with a goddess spoken of as Anna Perenna. The Latins, like the Greeks, knew no language but their own, and they had no critical knowledge even of their own tongue. They therefore naturally referred the name to Latin words, and connected it with Annus, *a year*, and Perennis, *of a year* or *yearly*. She was thus the bestower of fruitful seasons; and in this case the explanation happens to correspond with the original force of the name, if Anna Perenna be, as seems likely, the Hindu Apna Purna, who is spoken of as one in whom all good is united, who gives subsistence, and wears a robe of many colours. The title, Apna, points to nourishment by water, apa [ACHERON], while the name Puona comes apparently from the same stem with the Latin pario, to produce; hence parent.

ANOSTOS, in Greek mythology, is strictly 'the bourne from which no traveller returns'; in other words, the unseen land, whether this be Hades or the gardens of the Elysian paradise. It answers also to the charmed region into which the Venus of the Horselberg entices TANHAÜSER, and into which the Fairy Queen draws THOMAS THE RIMER of Ercildoune.

ANTAIOS, Antæus, in the stories of the exploits of Herakles, is an uncouth, awkward giant, whom the hero finds it most difficult to overcome, because he received fresh strength whenever he touched the earth. Hence Herakles can subdue him only by lifting him off the earth and strangling him in the air. Antaios is clearly a huge monster who may be compared with the Kyklops [Cyclops], POLYPHEMOS, who feeds his flocks on the hill-side. But clouds in a thousand stories of all countries are described as flocks. They are, for instance, the sheep in the legend of Dummling, who points them out as reflected in the water to the stupid farmers who jump in to recover them. The story of Antaios is thus at once explained. The black storm-vapour draws to itself new strength from the earth on which it reposes, and the sun cannot burn up and disperse it until his heat has lifted them up above the surface of the land.

ANTEIA [BELLEROPHON.]

ANTIGONE [ŒDIPUS].

ANTILOCHOS, in Greek mythology, the slayer of the Ethiopian MEMNON.

ANTIOPE [AMPHION].

ANTIPHATES, in the Odyssey, is the chief of the savage Laistrygonians, who has his dwelling in Lamos, a place described as being on the confines of Day and Night, and surrounded by rocks rising sheer and smooth from the sea. The name Lamos is connected with that of the Lamuroi, a race of goblins or monsters, who *swallow* all that comes in their way; and the people of Antiphates are thus akin to those of Polyphemos [CYCLOPS.] From him, as from Polyphemos, Odysseus [Ulysses] escapes with great difficulty by cutting the mooring-ropes of his ships.

APHRODITE, in Greek mythology, is the embodiment of love and beauty. According to the Hesiodic Theogony, or *birth of the gods*, she sprang from the foam of the sea on which had been poured the blood of *Ouranos* (Uranus) on his being mutilated by his children. If the name Aphrodite be Greek, the conjecture which identifies it with our word *froth*, through the Greek ἀφρος (a-phrod-s), *foam*, might be accepted as true. Others contend that it is only a Greek form of the name of Astarte, the Semitic Ashtoreth, the intermediate links being Aphtoret and Aphrotet; but we cannot regard this as more than a guess. All that we can say is that certain names in Greek mythology are beyond doubt Semitic, or Hebrew, or Canaanitish. Thus Melikertes is Melkarth, ADONIS is Adonai, and Palaimon is Baalhamon. The name Aphrodite may belong to the same class, and her worship is described as coming specially from Cyprus, an island where the Phenicians had long been settled as traders and miners. But, although there was unquestionably an Asiatic Aphrodite, there are yet features in her character which are strictly Aryan—or which, in other words, belong to the mythology of that primitive people from whom Greeks, Latins, French, Germans, Persians, Scandinavians, and other nations of the same stock have sprung. Her birth from the sea is the birth of the morning which springs first from the ocean; and so Athênê also is born by the waterside. On her, therefore, is lavished all the wealth of words which denote the loveliness of the dawn. The grass is said to spring up under her feet as she moves; Eros, *love*, walks by her side, and Himeros, *longing*, follows after her. As rising from the sea she is Anadyomene, and also Enalia and Pontia, the queen of the waters.

In the Odyssey she is the wife of the fire-god Hephaistos, and she is attended by the CHARITES, who answer to the Latin Gratiæ, the Graces. But in the Iliad the wife of Hephaistos is Charis, and thus we find that both Aphrodite and Charis are mere names for the glistening dawn; and so in the oldest Hindu books we find the same name, in the form Harits, used to denote the horses of the sun, from their gleaming as with fat or ointment.

Aphrodite is endowed, as we should expect, with arrows irresistible as those of Phœbus, the rays which stream like spears from the flaming sun, and also with the magic ring which we have already seen in the keeping of ANDVARI, the dwarf, and which belongs also to Venus, Freya, Holda, as well as to Helen, Harmonia, and Brynhild. This ring is everywhere the fruitful source of evil and disaster, just as from Pandora men are said to receive nothing but misery and mischief.

Of this beautiful, capricious, and sometimes malignant being no very connected story is told, but almost everything said of her explains itself. Love may be either pure or unholy. As denoting the former, she is Aphrodite Ourania, or the heavenly; as favouring merely sensual passion, she is Aphrodite Pandemos, the idol of the common herd. She is the mother of countless children, some lovely, some

hideous, as we should expect when we remember that the old phrases described the morning as the child of the darkness, and the evening as the mother of the darkness again. Hence she is said to have given birth to Echidna, the throttling snake, to Typhon, the lowering storm-cloud, to Phobos and Deimos, fear and dread, as well as to Bacchus and Priapos. She is the lover of ADONIS, and also of ANCHISES.

The Kestos, or Cestus, of Aphrodite is only another form of the ring or necklace of Harmonia [AMPHIARAOS]. It has the power of inspiring love, and as such is used by Hêrê, in the Iliad, when she wishes to prevent Zeus from marring her designs.

APIS, the calf-god of the Egyptians, was identified by Herodotus and other Greek writers with Epaphos, the son of the horned maiden Io. This calf-god was supposed to manifest himself from time to time in a bull, which being recognised by certain signs was consecrated and received high worship. It was not suffered to live more than twenty-five years, and his burial was followed by a general mourning, until a new calf with the proper marks was discovered. The Egyptian Apis was the son of Isis, and during his life was called Hapi-anch, or the Living Apis. At his death he was canonized, and became Osir-Hapi, or the Dead Apis—a name which the Greeks inverted into Serapis.

APOLLON [Apollo], generally spoken of as Phoibos Apollon, is the great god of light and life in the mythology of the Greeks. His birth and his character are dwelt on especially in the so-called Homeric hymn addressed to him, which really consists of two songs. The first tells the simple tale that Leto, the mother of the unborn god, could find no place to receive her until she came to Delos. To wealthier and more fertile lands she made her prayer in vain, and when she called on the little stony island with its rugged cliffs and hills, Delos trembled with joy and fear. The island, it is said, knew that the unborn child would be a being of mighty power, and feared that he might despise his barren birthplace, and spurn it with his foot into the sea. To remove this fear, Leto made a solemn covenant with Delos that here should be the sanctuary of the child for ever, and that his worshippers, coming from all lands to his high festival, should lavish on her inexhaustible wealth. Then Leto cast her arms round a tall palm-tree, as she reclined on the bank of Kynthos, and the babe leaped to life and light as the earth smiled around her. The nymphs bathed him in pure water, and wrapping him in a glistening robe, placed a golden band round his body, while Thetis touched his lips with the food and drink of the gods. No sooner had the child received this nourishment than he was endowed with an irresistible strength, and his swaddling bands fell off from him like flax.

This is manifestly a picture of the upspringing of the sun, who must be born in Delos, which means merely the bright land, like Argos or Arkadia. But it was naturally supposed that he was born in the island so named, and the belief found expression in the gathering of all the Ionian tribes at the great Delian festival.

The second song, far from saying that Apollon should abide always in the land of his birth, speaks of him as pre-eminently a wanderer, although he always returns to the home which he had left, as necessarily the sun must do. The whole legend thus becomes transparent. The name Leto denotes, like Lethe and Latmos, the slumber of night, in which men forget alike their joys and their sorrows; and the poet found himself unconsciously compelled to speak of her as seeking only the lofty crags and mountain summits. Plains and valleys it would clearly be useless to seek; the light of the sun must rest on the hill-tops long before it reaches the dells beneath. Even in the Phœnix, or palm, round which she rests her arms, we have simply the purple hue of dawn.

Having cast aside his swaddling clothes, Apollon, the hymn-writer goes on to say, began his long journey westwards. The first stage brought him to the Bœotian fountain of Telphoussa, near whose waters be began to lay the foundations of a shrine. But the nymph scared him away by warnings of the din of horses and of cattle brought there to watering; and the god, following her counsels, betook himself to Parnassus, where Trophonios and Agamedes raised for him his world-renowned home, which bore the name of Pytho, from his slaughter of the great worm or dragon, which imprisoned the waters and plagued the land with drought.

For this sanctuary it was needful now to find a body of priests and servants, and these he found in the crew of a Cretan ship sailing with merchandise to Pylos. In the form of a dolphin Apollon urged the vessel through the waters, and hence his temple was known as that of Delphi, the home of the (Delphinian) Dolphin-god. When the ship reached the haven, Apollon leaped from the waters like a star, while from him flew sparks of light till their radiance reached the heaven. Hastening to his sanctuary, and showing his weapons in the flames which he kindled, he hastened with the swiftness of thought back to the ship, now in the form of a beautiful youth, with golden locks flowing over his shoulders.

He has thus the power of changing his shape at will, and may, therefore, be compared with the Greek Proteus, with the Syrian fish-god Dagon or Onnes, and with the fish-raja in Hindu fairy tales. All these beings are endowed with marvellous wisdom, as the eye of the sun is said to penetrate even into the hidden depths of the sea.

The wisdom of Apollon is, indeed, unfathomable, and it is also in its essence incommunicable, for when he demands the harp of HERMES, and the latter seeks for the gift of Apollon's wisdom in return for his own gift of song, the reply is that he cannot have this wisdom in its fulness, inasmuch as it is impossible to share it with another. Hermes is the maker of the harp and the true lord of song, but Apollon is the one being who, as surveying all things throughout the wide world, can enter into the secret counsels of Zeus.

Like all the wandering gods, he has many loves in many lands, and to these his love is fatal. Among these is Daphne, the daughter of the Arkadian Ladon, or of the Thessalian stream Peneios,—in other words, the child of the earth springing from the waters when the first flush of light trembles across the sky. But as the dawn fades before the deepening splendour of the sun, so Daphne flies from Apollon, as he seeks to win her. The more eager his chase, the more rapid is her flight, until in despair she prays that the earth or the waters may deliver her from her persecutor; and so the story went that the laurel tree grew up on the spot where she vanished, or that Daphne herself was changed into the laurel tree. But Daphne (from a root *dah*, to burn) is only a name for the dawn,

The laurel, as a wood that burns easily, received the same name; and the transformation was thus rendered inevitable.

Another maiden loved by Apollon was Koronis, who became the mother of ASKLEPIOS [Æsculapius]. When her body was burnt, the child, it is said, was born amidst the flames,—a story which corresponds to that of the birth of Dionysos, and the death of his mother Semele.

(To be continued.)

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The Elements of Mental and Moral Science as applied to Teaching.

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[These articles are specially written to meet the requirements of candidates who are reading for the certificate examination.]

CONSCIOUSNESS AND ATTENTION.

CONSCIOUSNESS cannot be accurately defined. It is that without which all mental phenomena are impossible. It has been defined as 'a knowing, and a knowing that we know': but this only throws the difficulty a step farther back, and in order to understand Consciousness each must fall back upon his own experience. We know what Consciousness is as we know what red is, yet we cannot give an accurate description of either. Combined with Consciousness is the fixed belief in the existence of that of which we are conscious. I am conscious of a bright object before me: immediately I entertain the firm belief (*a*) that there *is* before me a bright object, and (*b*) that it is *I* who perceived it. This second belief proves that Consciousness implies memory, for otherwise there could be no connection between the I who perceived and the I who believed. Memory bridges over the gulf, and asserts that the two I's are the same. In other words memory and consciousness are both required to explain the confidence we have in our self-identity. I know that I am the I of yesterday, because I was conscious yesterday, and am conscious to day that I was conscious yesterday.

Consciousness may be vague and diffuse, or intense and concentrated. We may be conscious of all that goes on around us without taking particular notice of anything, or we may be so intent upon something that we become unconscious of everything else. In the first case Consciousness is weak but widely distributed, in the second strong but limited to a small area. In general terms, then, the intensity of Consciousness diminishes as the area of its action increases. This power of concentrating Consciousness is called Attention, and is of the utmost importance in teaching. If there be degrees in the absolute amount of Consciousness possessed by different individuals this amount depends upon the physical constitution of the person, and not upon education. Though the teacher cannot increase the total force of Consciousness, however, he can do very much in enabling a child to apply to most advantage the force with which he is endowed.

The two qualities of attention that a teacher must seek to cultivate are (*a*) intensity, and (*b*) facility in changing the object. Of these the former is the more important; yet it may be overprized, and the many stories told about absent-minded philosophers, are so many reproaches against a system of training which cultivates a part at the expense of the whole. The aim of education ought to be to make a man complete master of himself, and if a man cannot readily change his line of thought, he cannot be said to be truly free. The highest minds really display both powers, for while a man with the power of intense attention may discover many facts, it requires a man with the additional power of rapid change of attention to consider all those facts at once, and explain their relations to one another. A distinction is usually made between Voluntary and Involuntary Attention. We must start from the latter in our teaching, and progress in the development of the faculties depends upon the degree in which we supersede involuntary by voluntary attention. But involuntary attention is not to be altogether suppressed. It is for our physical well-being that striking objects should attract our attention apart from the will; and in true scientific observation the will only limits the field of attention, and within that field depends for its results upon involuntary attention. The involuntary form, then, is the more fundamental of the two, and from it we must start in our efforts to train the Attention.

Like the other faculties, Attention can only be fully developed through practice; and for the sake of efficient practice we must discover the most favourable conditions of its exercise. These conditions are of two kinds, positive and negative. Thus if we wish to lead the attention in any particular direction we must make that direction positively attractive, and at the same time remove all attractions towards other directions. The result of this care is Attention which on the part of the pupil is purely involuntary, though it results from the will of the teacher. The child is really unconsciously compelled to attend. To reach the higher form of attention, therefore, the positive attractions must be one by one removed, till the will has acquired the power of concentrating the attention upon objects not at all attractive. This removal of props as the will strengthens, however, does not include the negative aids. It would be absurd to expose a child to noise and temptations to play, merely in order to strengthen his power of regulating his attention. A teacher has enough to overcome without creating new obstacles.

The negative conditions of attention must be maintained all through school life. The most important are the absence of noise, of excessive heat or cold, of bad air, and of other causes of physical discomfort. Next, distractions from seeing out of windows must be removed. It does not follow that, to be consistent, we must have a bare and unadorned schoolroom. Pretty flowers, and pictures, and shells, and even texts, certainly are both desirable in themselves and of educational value, while they do not interfere with attention. The children see them every day: they lack novelty, that most deadly fly of the angler for Attention, and therefore readily give place to anything new which the teacher brings forward. On the other hand, whenever the teacher ceases to make demands upon their Attention—as he must at frequent intervals with young classes—it dissipates itself into a vaguer form, which includes all the pretty things. This diffused attention *must* be expended as a relief, and the skilful teacher prefers to expend it pleasantly in

cultivating good taste, rather than in the stolid contemplation of blank walls.

Having brought his pupils to a happy medium between discomfort and luxury—for it is possible to make the children too comfortable—the teacher must bring forward positive inducements to attention. With the youngest classes all sorts of devices may be used:—pictures, movable letters, ball frame, wooden models, blackboard drawing, anything which will *compel* attention. At the next stage the aid of actual tangible attractions is to a great extent given up. The teacher by ever varying tricks of voice and manner must maintain by skill an attention he formerly gained by what was really force. However clever the teacher may be he is not so attractive as a new picture or a bluebottle, and he will find it now necessary to supplement his own attractions by the prospect of discomfort to his pupils, if they do not attend. Their attention is now no longer purely involuntary. They attend mainly because they like to, but partly because they will to do so rather than face certain disagreeable contingencies. At this stage one of the main charms of the teacher is the wonder what he will do next: but a time comes when more systematic work is necessary. At this third stage the teacher must depend upon many mechanical devices—taking places, making one child question the others, word games, pointing places on map, spelling matches, dialogue readings, and other attractive ways of occasionally varying the routine.

In the higher classes we get beyond these gross attractions. It is of this stage that Bain maintains:—'There comes, then, the stern conclusion that the uninteresting must be faced at last. The age of drudgery must commence: every motive that can avert it is in the end exhausted.' But even here we have the strong external impulse derived from emulation and from the desire of knowledge, whether for its own sake or for its utility; and, given a motive for study, it is difficult to imagine any subject uninteresting. No subject is made up of absolutely isolated facts, and every relation discovered is a pleasure. Even lists of figures may become interesting, and many students have quite a love for getting up statistics. Here then a teacher's main work lies in pointing out relations.

Thus Analysis of Sentences should always be taught in the light of sentence building, and its close relation to parsing clearly shown. Algebra can be shown to be but an extension of Arithmetic. Practical Geometry and some of the propositions of Euclid are mutually explanatory. History should always be taught with a map. In Physical Science any one subject can hardly be kept apart from the others. By thus making clear the relations of all subjects of study we not only train the attention, but we teach in the best possible way whatever subject we may be engaged with. When the pupil gets a glimmering of the fact that all science is one, there is little fear that he will, in his after studies, find uninteresting any subject to which he wills to direct his attention.

IV. SENSATION AND PERCEPTION.

Sensation is a state of mind produced by an affection of the body. It is purely passive and subjective, that is, it does not in itself imply that there exists anything but the sentient being. Our knowledge of the external world as such is the result of a higher mental process called Perception. We have the sensations of light and heat. The mind finds these two associated, and assumes for them an existence in a substance outside of the body, and we have the perception of fire. Perception is the localization of sensation. It will be seen that Perception practically amounts to no more than the observation that certain sensations always occur together, and the assumption that some*thing* must exist to give rise to this constant combination. Thus I think I see a particular substance before me which I call an orange, whereas all that I really know is that my sensations of roundness, yellowness and roughness have always hitherto implied certain other sensations as sourness, moistness; and that all these sensations taken together make up what is usually understood by orange. The senses are never deceived. If I am deluded into believing a picture of an orange is a real fruit, my senses are not at fault, but my reasoning about my senses, in other words, my Perception.

It is thus evident that a main part of perception lies in the proper grouping of what are called *sensations*, with regard to the mind perceiving, but *qualities* with regard to the object in which they are supposed to inhere. Thus heat is a sensation to me, but a quality of a fire. Sensation deals only with heat, perception with hot things, or rather with the quality of heat as found in *things*. It is a recognised law that sensation and perception vary inversely in intensity. That is, the stronger the sensation the less the power of localizing it accurately. Thus passing the fingers lightly over a substance we have the minimum of Sensation with the maximum of Perception, while if we press heavily the conditions are reversed.

We have already seen that without sensation all knowledge is impossible, and the senses have been not inaptly termed the five gateways of knowledge. Yet sensation, as such, can be little cultivated in school. This is the less to be regretted that nature has implanted a universal desire in children to exercise their senses. Perception, rather than sensation, can be trained by the teacher, and even that chiefly by utilizing the ordinary school work, and especially by supplying names which materially assist perception by enabling us to recall past sensations. It must be kept in view that our aim in school is to develop the nature of the children all round, and not to seek to make them equal cats and dogs in their sense perceptions. We are told that sailors see twice as far over the water as landsmen can, and the implied reproach is that sense training is neglected. But all this sense acuteness in special callings is acquired at the expense of the other senses. Our aim in school is to teach the right use of all the senses, and to give as much practice as possible in their exercise, not to single out this or that sense for special attention.

There is one general sense, the so-called muscular sense. It only demands a passing notice as it is that which gives us a guide to the sanitary state of the school, by producing such general states as depression, exhilaration, languor. It has no special organ, and cannot be trained in school. Of the five special senses taste and smell can receive very little direct training in school, but we can encourage their development by lessons on the names of smells and tastes. In such lessons we are practically convinced of the primary nature of sensation, for we find that we cannot describe a sensation. A blind man can never get a true notion of what red is, however much he may hear about it, and if a child have no sense of smell no amount of

speaking can make him know the scent of a rose. Indeed, grown up people can only describe a smell by comparing it with some other smell.

Our first sense lessons, then, must begin with giving the children names for certain qualities as found in objects. With the sense of smell this is particularly difficult, for there are no definite names. In general terms we can let them know that pleasant smells are called scents, and unpleasant, stinks. Then examples of scents may be given: rose, musk, lavender, eau-de-cologne. Sharp scents may be illustrated by smelling salts, camphor; fetid smells by rotten eggs. It is not that there are few distinct smells, but that each stands by itself: they are not yet grouped into classes. Though nameless, the different smells are so distinct that Sydney Smith, half in jest, half in earnest, proposed to establish an alphabet of smells for deaf mutes.

The tastes are more easily grouped. We can make children understand what sourness means by reminding them of the taste of vinegar. They will then readily give other examples as orange, crab apples, rhubarb. Similarly beginning with quinine, the taste of which many of the children know, we get the taste of bitterness illustrated by reference to almonds, or the stone of a plum. In teaching I got from a little boy the 'wax of the ear' as an example of bitterness; another gave 'beer.' So sweetness may be illustrated by sugar, treacle, figs; saltness by salt or salt water; insipidity or tastelessness by fresh water. Taste and smell are the only two senses liable to be confounded with one another. Thus a child sometimes describes a lozenge as having 'the taste of the smell of roses.'

Touch can be more definitely trained: and since touch is absolutely necessary to the full development of the sense of vision, these two may be treated together. Touch is a diffused sense, but it is specially keen at the finger tips, and the tip of the tongue. Its delicacy is tested by the power of distinguishing two points as separate. On the back, for example, the two points of a pair of compasses would require to be three inches apart in order to be separately perceived. The tip of the forefinger distinguishes them when within $\frac{1}{16}$ or even $\frac{1}{24}$ of an inch of each other. The eye is the organ of the sense of vision, a sense which takes account of three distinct qualities of matter,—form, size, colour. The sense applied to form and size must be trained in conjunction with touch. At first everything seems to be in the eye. The baby stretches out his hand to grasp the most distant objects, and it is only by repeated trials that sight and touch, working together, give the notion of size or distance. When we see a rough surface, we know that it is rough because the peculiar appearance of light and shade which it presents has always been accompanied in our past experience by a peculiar sensation of touch. Hence the necessity of letting children handle, as well as look at objects.

In teaching form the alphabet lesson may be utilized. Horizontal lines called for simplicity 'lines straight along,' and vertical lines or 'lines straight up,' may be illustrated by the capital letters E, F, H, I, L, T. Oblique lines, or 'squinting lines,' are added in the letters A, K, M, N, V, W, X, Y, Z. Curves and straight lines are combined in B, D, J, U, P. Curves predominate in C, G, O, Q, R, S. These four Classes might be named for the children the straight family, the squint family, the straight-round family, and the curly family. This, with the occasional reference to member of the same family as brothers and sisters, will serve the threefold end of increasing their interest, fixing their attention upon the points in which the letters resemble each other, and preparing their minds for the training in classification which is necessary for the development of the conceptive faculty. By drawing the letters on the blackboard, and at the same time naming each part as it is drawn, we impress the idea of the form while we aid the ordinary work of the school. The children copy on their slates, as the teacher reads off, 'straight up, straight along, straight up—H; straight up, straight along, curve, straight along—P.' The writing lesson, and more especially the drawing lesson, cannot fail to give full scope for the development of the rudimentary knowledge of form thus obtained.

To train the colour sense it is necessary to have some apparatus. In German and American schools coloured worsted and ribbons are used very successfully in conveying correct ideas of the different colours. But this apparatus fails in showing the relation between the primary and the secondary colours. It is difficult to show with coloured worsted that yellow and blue make green. Whereas with several squares of coloured glass, and a sheet of white paper as back ground, colour combinations can be formed easily and accurately. A dozen pieces of glass, four red, four blue, and four yellow, will be enough for a very complete course of colour training. Red, blue, and yellow are usually regarded as the primary colours. By covering a red glass with a blue we get purple; red with yellow gives orange, yellow with blue gives green. Purple, orange, and green are called secondary colours. By combining the secondaries and the primaries, or the secondaries among themselves we get tertiary or quaternary colours. These are more or less indefinite, yet names like violet, russet, olive are quite definite enough to be taught. Further combinations of colours are described by their resemblance to some known object of fixed colour. Thus we have rose coloured, salmon coloured, straw coloured; and when any new colour is invented it is named on the same principle as the recent 'crushed strawberry.'

Our coloured glass cannot take us beyond very definite colours, which is not to be regretted since the number of names we thus obtain is quite as large as young children are able to master. For further training the elaborate German colour charts are very useful, but a teacher with a good eye for colour can readily supply their place, if he have but a box of colours and a sheet of cheap cartridge paper. The rough mixtures he makes in the presence of his pupils will perhaps be less accurate than the colours of the chart, but they will rouse more interest, and will show more clearly the process of combination.

It is only fair to mention here that scientific men now maintain that the primary colours are not red, blue, and yellow, but red, green, and violet. This, however, need not prevent us from teaching as above; for though theories of vibration may prove the more fundamental nature of green and violet, we are not in school dealing with vibrations but colours. Red, blue, and yellow are the best set of colours to start from. In this sense artists recognise them as primary.

A certain parallelism has been made out between sight and sound. Form in vision may be compared to time in sound; size to tone; colour to pitch. Further the seven colours of the spectrum may be

compared to the seven notes of the octave; and the three primary colours to the three primary notes in the octave. The time of a sound is its quality as long or short; its pitch is its quality as high or low; its tone is its quality as deep or shrill. Two C's on the same piano differ in pitch. C on the piano and C sung, or sounded on a violin, differ in tone.

Singing trains the sense of sound all round, but that part of the music lesson which is of most value in sense training is the ear exercise. To write down the notes as sung or played in a given key is to make an accurate discrimination in pitch. Higher exercises in which a simple air is played over, and has to be written down, involve time training as well. Part songs give a notion of sound combinations which correspond to secondary and tertiary colours. In singing tone is of little consequence, in fact, with a class singing in unison, the teacher seeks to get rid altogether of the difference of tone among the voices. It is fortunate that this quality of tone, so little attended to in singing, is of very great importance in every day life. The children cannot help distinguishing sounds by this quality, and the teacher must supply them with names. Here as among the compound colours we can only give descriptive names: 'Reedy toned; bell toned;' and such general terms as 'sonorous, deep, shrill, squeaky.'

The sense of sound does not depend entirely upon singing for its development. The ordinary Reading lesson, and especially when in verse, gives great scope for practice in all three qualities of sound. Pronunciation and modulation demand a knowledge of pitch; attention to expression as indicated by punctuation trains the time-sense of the ear; and regulating the voice to suit the matter gives scope for variety of tone. So marching exercises and rhythmic gymnastic movements of the limbs train the ear to accuracy in time. And just as the colour sense is unconsciously trained by the maps, flowers, pictures, and shells in the school room, so the ear is unconsciously refined by the ease with which a strange sound can be detected in the comparative stillness of a well managed school, and especially by the quiet clearly articulated words of the teacher.

Sense training implies a capacity, and of this capacity some children are destitute. Colour-blindness and 'having no ear' are similar defects, and ought to be discovered for the sake of the pupil, as well as for the good of others. A bad ear seldom does harm to any but its unfortunate possessor, whereas colour blindness may lead, and has led, to great loss of life in the case of pilots and railway officials. Since it is estimated that 1·3 per cent of men are colour blind, we may expect to find cases even in our smallest schools. It exists in three degrees. There may be no colour perception at all. All pictures appear like photographs. This kind is easily detected. There may be inability to distinguish between complementary colours as green and red, blue and orange. The third, and least serious form, shows itself in inability to distinguish between closely allied colours, and between shades of the same colour. By means of our coloured glass all cases of colour blindness can be easily detected and classified. In the same way an ear exercise soon detects the boy with no ear for pitch. The sense of time is much less frequently absent. It may be readily tested by making the child read a poem written in prose.

(To be continued.)

Chemistry of the Non-Metallics.

[This series of articles, whilst dealing with the subjects required by the University of London for the Matriculation Examination and with those required at the Elementary Stage of the Inorganic Chemistry (Branch X.) Science and Art Department, is intended as a practical guide to the philosophical and systematic study of the non-metallics.]

CHAPTER XXI.

HYDROGEN SULPHIDE.

Tests for Metals.

HYDROGEN SULPHIDE, SULPHURETTED HYDROGEN.

(*a*) H^2S.

(*b*) 34.

(*c*) FIRST PREPARATION.—By direct union of its elements.

(1) Pass a current of hydrogen gas through boiling sulphur, or burn hydrogen in sulphur vapour, or sulphur in hydrogen.

(2) $2H^2+2S=2H^2S$

(3) 4 +64=68

4 vols. 4 vols.

SECOND PREPARATION.—From iron sulphide and sulphuric acid.

(1) From sulphide (ferrous sulphide, *not* ferric sulphide or iron pyrites FeS^2) placed in an apparatus similar to that used in making hydrogen, is treated with hydrogen sulphate. Iron sulphate and hydrogen sulphide are formed. The gas escapes, and is caught over *warm* water.

(2) $FeS+H^2SO^4=FeSO^4+H^2S$

88 +98 =152 +34

2 vols.

THIRD PREPARATION.—From antimony sulphide and hydrochloric acid.

Place the antimony sulphide in a flask with strong hydrochloric acid and heat the mixture.

$Sb_2S_3+6HCl=2SbCl_3+3H^2S$

340 +219 =457 +102

6 vols.

Notice, that as antimony is trivalent, 2 atoms of it combine with 3 atoms of the divalent sulphur, and 1 atom of it with 3 of the monovalent chlorine.

(*d*) (1) Gas. Liquefied under pressure of 17 atmospheres at 10°; solidifies at 85°.

(2) With very offensive odour, like that of rotten eggs. Colourless.

(3) 17, or $\frac{17}{14{\cdot}47}$. The liquid has specific gravity ·9.

(4) Soluble in water, 100 C.C. of water dissolve 300 C.C. of hydrogen sulphide. This solution, or better, a solution of the gas in glycerine, is one of the most important liquids in the laboratory. It is the great test-agent for metals, as the salts of metals, treated with hydrogen sulphide, yield sulphides of the metals varying in their solubility in neutral, acid, or alkaline liquids, and varying in colour.

The sulphides of the alkaline metals, potassium, sodium, and ammonium, and of the metals of the alkaline earths, calcium, barium, strontium, are not soluble, and therefore the salts of these metals yield us precipitate with hydrogen sulphide. In a solution that is rendered acid with hydrochloric acid, the sulphides of the following metals are precipitated: Arsenic (yellow); antimony (orange); tin (brown yellow); mercury, lead, bismuth, copper (all black); cadmium (yellow). The first three sulphides are soluble in ammonium sulphide. Those of the other five metals are not soluble in this liquid. In alkaline solutions sulphides or oxides of the following metals are precipitated. Iron, cobalt, nickel (all black sulphides), manganese (flesh-coloured sulphide), zinc (white sulphide), aluminium (white hydrated oxide), chromium (green-white hydrated oxide).

The student should now apply hydrogen sulphide in solution to the following compounds, and note the results :—

Arsenious acid (white arsenic of the shops) in a solution acidulated with hydrochloric acid.

$$As^2O^3+3H^2S=As^2S^3+3H^2O$$
$$198 \quad +102 \quad =246 \quad +54.$$

Copper sulphate (acidulated with hydrochloric acid).

$$CuSO^4+H^2S=CuS+H^2SO^4$$
$$159 \quad +34 \quad =95 \quad +98.$$

Lead nitrate (acidulated).

$$Pb2NO^3+H^2S=PbS+2HNO^3$$
$$331 \quad +34 \quad =239+126.$$

Antimony chloride (acidulated).

$$2SbCl_3+3H^2S=Sb_2^{\cdot\cdot}S_3^{\cdot\cdot}+6HCl$$
$$457 \quad +102 \quad =340 \quad +219.$$

Zinc sulphate (in neutral solution).

$$ZnSO^4+H^2S=ZnS+H^2SO^4$$
$$161 \quad +34 \quad =97 \quad +98.$$

Iron sulphate (in an alkaline solution).

$$FeSO^4+H^2S=FeS+H^2SO^4$$
$$152 \quad +34 \quad =88 \quad +98.$$

Magnesium sulphate ; no precipitate.

$$MgSO^4+H^2S=MgS+H^2SO^4$$
$$120 \quad +34 \quad =56 \quad +98.$$

(5) Combustible, burning with a blue flame, and forming sulphur dioxide and hydrogen oxide.

$$2H^2S+3O_2=2H^2O+2SO^2$$
$$68 \quad +96 \quad =36 \quad +128$$
$$4 \text{ vols.} \quad 6 \text{ vols.} \quad 4 \text{ vols.} \quad 4 \text{ vols.}$$

If the supply of oxygen is not sufficient, only the hydrogen is oxidised, and sulphur is deposited.

(6) Poisonous. Acid reaction.

With chlorine, hydrogen sulphide decomposes, yielding hydrochloric acid and free sulphur.

$$H_2S+Cl_2=2HCl+S$$
$$34 \quad +71 \quad =73 \quad +32$$
$$2 \text{ vols.} \quad 2 \text{ vols.} \quad 4 \text{ vols.}$$

EXAMPLES ON HYDROGEN SULPHIDE. (*Solved.*)

(118) What is the formula of copper sulphide, if its percentage composition is 66$\frac{2}{3}$ copper, 33$\frac{1}{3}$ sulphur?

$$\frac{66\frac{2}{3}}{63}Cu \text{ to } \frac{33\frac{1}{3}}{32}S$$
$$1260 \text{ to } 640$$
$$126 \text{ to } 64.$$

Dividing by 63 and 32 (the weight numbers of Cu and S) we have 2 to 2

1 to 1

Formula=CuS.

(119) Find the weight of hydrogen sulphide necessary to precipitate the solution of a mixture of 311 grams of copper sulphate and iron sulphate in the proportion of their molecular weights.

The 311 grams consist of 159 $CuSO^4$, 152 $FeSO^4$.

159 $CuSO^4$ need 34 grams H^2S

152 $FeSO^4$,, 34 ,,

∴ 68 grams are needed.

EXAMPLES ON HYDROGEN SULPHIDE. (*For Solution.*)

(123) Find the formula of bismuth sulphide if the percentage composition is bismuth 81$\frac{81}{117}$, sulphur 18$\frac{36}{117}$ (bismuth is a triad). . . . . Bi^2S^3.

(124) What weight of lead acetate will be precipitated by the hydrogen sulphide evolved from the action of 24$\frac{1}{2}$ grams of sulphuric acid on 25 grams of iron sulphide? . 81$\frac{1}{2}$ grams.

CHAPTER XXII.

PHOSPHORUS: PREPARATION, FORMS, PROPERTIES.

A. P.

B. 31.

C. From bones.

(1) Take a bone of some animal ; clean it from flesh and fat, and heat it in a Bunsen burner. The heated part becomes first black, then white. The blackness is due to the fact that the animal matter of the bone is first partly decomposed ; the hydrogen, oxygen, nitrogen gases are driven off, whilst the more durable carbon remains. The after whiteness is due to the oxidation even of the carbon, and the complete elimination of the organic or animal matter. That which then remains is only the inorganic or earthy matter of the bone, the salts.

Place another similar bone in weak hydrochloric acid for some hours. When the bone is removed, its shape is exactly the same as it was originally, but the bone is now perfectly flexible. All the mineral matter has been dissolved out by the hydrochloric acid, and only the animal matter left. Neutralise the acid solution with a solution of ammonia, and the dissolved bone salts are precipitated as a white mass.

From these experiments we learn that bone consists of two sets of materials ; the animal, organic ; the mineral, inorganic, earthy. The animal matter is gelatine, and gives to bone elasticity. The mineral gives hardness and resistance. The mineral matter consists of several salts, of which calcium phosphate is the principal. The percentage consumption of human bone follows.

Animal matter,	Gelatin, 33·3 per cent.
Earthy matter,	Calcium phosphate, 51·04.
	Calcium carbonate, 11·3.
	Calcium fluoride, 2.
	Magnesium Phosphate, 1·16.
	Sodium Chloride, 1·2.

In order to prepare phosphorus from bones, the bones are burnt to get rid of the gelatine or animal constituent. Or in the laboratory they are treated with hydrochloric acid, as in the experiment described above, and the bone earth after drying is mixed with dilute sulphuric acid. Thus calcium sulphate and tetra-hydrogen calcium phosphate (acid calcium phosphate, the super-phosphate of the former) is formed. Of these two salts, the former is the less soluble, and is allowed to crystallise out. Then the solution of the tetra-hydrogen calcium phosphate is evaporated until it is of a syrupy consistence, mixed with wood charcoal in the form of powder, and heated. Water is expelled, and the phosphate becomes calcium metaphosphate. This, further heated with the charcoal, reforms the original calcium phosphate, while carbon oxide is evolved, and phosphorus distils over into water.

(2 and 3) Calcium phosphate has symbol $Ca_32(PO_4)$. This symbol may present some difficulties even to the student who has understood all the preceding pages. It will be more comprehensible if it is built up from phosphorus itself. When phosphorus is burnt, phosphorus pentoxide is formed (P^2O^5). This combined with water yields hydrogen phosphate (phosphoric acid).

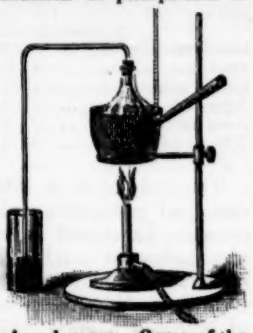
$$P^2O^5+3H^2O=H^2PO^4$$
$$142 \quad +54 \quad =196$$

To build up calcium phosphate from hydrogen phosphate, the hydrogen must be replaced by calcium. Calcium is a dyad. Therefore 1 atom of it replaces 2 atoms of hydrogen. Therefore in $2H^3PO^4$, the 6 atoms of hydrogen are replaced by 3 atoms of calcium, and the formula of calcium phosphate is $Ca_32(PO^4)$.

$$Ca^32PO^4+2H^2SO^4=2CaSO^4+CaH^42PO^4$$
$$310 \quad +196 \quad =272 \quad +234$$
$$CaH^42PO^4=Ca2(PO^3)+2H^2O$$
(calcium metaphosphate)
$$234 \quad =198 \quad +36$$
$$3[Ca2(PO^3)]+10C=Ca^32PO^4+10CO+4P$$
$$594 \quad +120=310 \quad +280 \quad +124$$
$$20 \text{ vols.}$$

D. (1) Solid, melting at 44°, boiling at 290°. Usually in the amorphous form or sticks ; the melted phosphorus is run into glass tubes immersed in cold water. Phosphorus is allotropic. Its forms are: α. The ordinary form just mentioned. β. Viseous phosphorus, formed by the sudden cooling of melted phosphorus when near its melting point. γ. A crystalline form (octahedral), obtained by evaporating the solution of phosphorus in carbon disulphide. δ. Red or amorphous phosphorus. ε. A rhombohedral form of the last.

This most important modification of phosphorus is formed by aid of the apparatus reproduced in Fig. 48. Place in the flask a quantity of ordinary phosphorus. Insert the flask in a saucepan filled with oil into which a thermometer dips. From the cork of the flask carry a long bent tube to a glass containing mercury. Drive out the air in the flask by a current of carbon dioxide. Then raise the temperature of the oil-bath to about 230°, and keep it at this temperature for 24 hours. The phosphorus melts, and afterwards becomes a hard, red mass. Some of the ordinary phosphorus is never transformed into the amorphous form, and this should be dissolved out in carbon disulphide.



A simpler method for the student is to place in a test tube containing hydrochloric acid, a piece of ordinary phosphorus, with a fragment of iodine, and immerse the test tube in boiling water for some time.

(2) With faint, garlic odour; colourless, transparent.

(3) 1·8. That of the red form is 2·2.

The specific gravity of the vapour is not normal. At 1040° it is not 31 but 62 times as heavy as hydrogen. Hence phosphorus is a ½ volume gas, and 31 grams of it, could they be obtained at O° and 760 mm., would occupy only 5·6 litres, not 11·2.

(4) Insoluble in water: soluble in dicarbon sulphide.

(5) Inflammable, forming phosphorus pentoxide.

$$4P + 5O_2 = 2P^2O^5$$
$$124 + 160 = 284$$
10 vols. 4 vols.

The red form may be heated to 250° without catching fire. On account of its inflammability phosphorus has to be kept under water, and is luminous in the dark. The presence of a very small quantity of oil of turpentine or of olefiant gas prevents this luminosity.

(6) Poisonous. Its vapour produces decay of the lower jawbone. The red form is, however, not poisonous nor does it affect the bones of the face. Many of the metals burn in the vapour of phosphorus. It is used in medicine, and for the making of lucifer matches. In the matches that (theoretically) ignite only on the box the phosphorus with antimony sulphide and glue forms the composition on the box and the matches are tipped with a mixture of potassium chlorate, antimony sulphide, and glue.

EXAMPLES ON PHOSPHORUS. (*Solved.*)

(120) If calcium phosphate constitutes 50 per cent. of the weight of a certain bone, what weight of the bone must be taken to yield enough phosphorus for the formation when combined with oxygen of 11·2 litres of phosphorus pentoxide, at a temperature of 273°?

273 vols. at O° become 546 at 273°
546 ,, 273° ,, 273 ,, O°
1 vol. ,, becomes $\frac{273}{546}$,, ,,
11·2 ,, ,, ,, $\frac{273\times11\cdot2}{546}$

22·4 litres P^2O^5 require 62 grams P
1 litre ,, requires $\frac{62}{22\cdot4}$,, ,,
$\frac{273\times11\cdot2}{546}$,, ,, $\frac{62\times273\times11\cdot2}{22\cdot4\times546}$

124 grams P. are yielded by 594 grams $Ca2PO^3$
1 gram ,, is ,, $\frac{594}{124}$,, ,,
$\frac{62\times273\times11\cdot2}{22\cdot4\times546}$,, ,, ,, ,, $\frac{594\times62\times278\times11\cdot2}{124\times22\cdot4\times546}$

198 grams $Ca2PO^3$ are yielded by treatment of 234 grams CaH^42PO^4

1 gram $Ca2PO^3$ is yielded by treatment of $\frac{234}{198}$ grams CaH^42PO^4
$\frac{594+62+273+11\cdot2}{124+22\cdot4+546}$ $Ca2PO^3$ are yielded by treatment of $\frac{324\times594\times62\times273\times11\cdot2}{198\times124\times22\cdot4\times546}$

234 grams CaH^42PO^4 are yielded by treatment of $310Ca_32PO^4$
1 gram ,, is ,, ,, $\frac{310}{324}$,,
$\frac{234\times594+62\times273\times11\cdot2}{198\times124\times22\cdot4\times546}$ grams CaH^42PO^4 are yielded by treatment of $\frac{310+234\times594\times62\times273\times11\cdot2}{234\times128\times124\times22.4\times546} = 1\frac{8}{4}$, and as calcium phosphate constitutes ½ the bone, the weight of bone required is $2\frac{1}{2}=232\frac{1}{2}$ grams.

(121) What is the volume of 15½ grams of phosphorus at temperature 260° and under pressure 777 mm?
31 grams P occupy 5·6 litres at normal temperature and pressure.

1 gram ,, occupies $\frac{5\cdot6}{31}$,, ,, ,,
$\frac{31}{2}$,, ,, occupy $\frac{5\cdot6\times31}{31\times2}$,, ,, ,,
273 vols, at O° become 533 at 260°
1 vol. ,, becomes $\frac{533}{273}$,,
$\frac{5\cdot6\times31}{31\times2}$,, ,, $\frac{533\times5\cdot6\times31}{273\times31\times2}$,,

Under pressure 760 mm. the volume is $\frac{533\times5\cdot6\times31}{273\times31\times2}$
,, 1 ,, ,, ,, $\times760$
,, 777 ,, ,, ,, $\times\frac{760}{777}$
$=5\frac{408}{1111}$ litres.

EXAMPLES ON PHOSPHORUS. (*For Solution.*)

(125) What weight of hydrogen is present in 117 grams of acid calcium phosphate? . . . . . 2 grams.

(126) What weight of carbon must be mixed with the calcium hydrogen phosphate obtainable from the treatment of 155 grams of calcium phosphate with calcium sulphate to decompose it completely? . . . . . 20 grams.

(129) Find the temperature at which 62 grams of phosphorus measure 33·6 litres? . . . . . 546°.

(To be continued.)

—o—

How I Teach Domestic Economy.

BY MRS. WIGLEY,

Author of 'Marshfield Maidens,' 'Our Home Work,' 'Workers at Home,' 'Royal Series Domestic Economy,' 'Cookery and Home Comforts,' 'The Merrywcathers,' 'Thoughts,' etc.

CHAPTER XV.

TABLES OF WASTE AND SUPPLY.

FIRST we will consider those given by Professor Church in his 'Food.'

TABLE SHOWING THE DAILY WASTE IN THE BODY.

		lbs.	ozs.	grns.	lbs.	ozs.	grns.
Oxygen	in the carbonic acid gas given out by the lungs...	1	7	325			
,,	in the carbonic acid gas given out by the skin	0	0	111			
,,	in the organic matter given out by the kidneys and intestines ...	0	0	357			
,,	in the water formed in the body	0	9	130			
	Total Oxygen in waste				2	2	47

	lbs. ozs. grns.	lbs. ozs. grns.
Carbon in the carbonic acid gas from the lungs	0 8 320	
,, in the carbonic acid gas from the skin	0 0 40	
,, in the organic matter from the kidneys	0 0 170	
,, in the same from the intestines...	0 0 308	
Total Carbon in waste...		0 9 400
Hydrogen in the water formed in the body and given out by the lungs and skin	0 1 70	
,, in the organic compounds given out by the kidneys and intestines	0 0 100	
Total Hydrogen in waste		0 1 170
Nitrogen in the urea and other waste given out by the kidneys	0 0 245	
,, in waste given out by the intestines	0 0 46	
Total Nitrogen in waste		0 0 291
Salts and Phosphates—Common salt given out by the skin	0 0 10	
,, Common salt given out by the kidneys	0 0 315	
Total Common Salt in waste		0 0 325
,, Phosphates and potash, chiefly from the kidneys	0 0 170	
Total Phosphates, etc....		0 0 170
Water taken in as such—Given out by the kidneys, lungs, skin, and intestines, in addition to that formed in the body	5 8 320	
Total daily waste		8 7 420

Now, from studying this table a little, we see that our daily waste amounts to about 8½ lbs., and that quite 5½ lbs. of this waste is water.

Our next table, taken from the same source, will show the necessary supply.

	lbs. ozs. grs.	lbs. ozs. grs.
Oxygen in the air breathed	1 10 115	
,, in starch, albumenates, and fat	0 7 370	
Total Oxygen		2 2 47
Carbon in fat, starch, albumenates		0 9 400
Hydrogen in same		0 1 170
Nitrogen in albumenates...		0 0 291
Common salt		0 0 325
Phosphates, potash, etc.		0 0 170
Water...		5 8 320
Total daily supply		8 7 410

The average daily diet for an adult should contain :—

	lbs. ozs. grs.
Water	5 8 320
Albumenates...	0 4 110
Starch, sugar, etc.	0 11 178
Fat	0 3 337
Common salt...	0 0 325
Phosphates, potash, &c.	0 0 170

In summing up at the end of the book, and laying before his readers some practical remarks as to diet, Professor Church thus says :—

'An adult man weighing 154 lbs. will require, therefore, if doing a fair amount of work—
Of Carbon... ..... 4,900 grains | Of Nitrogen ..... 300 grains

'The following table will show what quantity of the various foods are capable of supplying the necessary amount of carbon named for the day—

	lbs. ozs.		lbs. ozs.
Bacon	1 0	Wheaten bread	2 8
Scotch oatmeal	1 9	Eggs	5 3
Peas	1 10	Potatoes	6 6
Rice	1 11	Lean beef	6 6
Cheese...	1 11	Cow's milk	8 11
Wheaten flour	1 13	Turnips	20 0

'The necessary Nitrogen for one day would be furnished by—

	lbs. ozs.		lbs. ozs.
Gloucester cheese ...	0 15	Bacon	3 4
Peas	1 3	Rice	3 7
Scotch oatmeal	1 10	Wheaten bread	3 13
Eggs	2 0	Cow's milk	6 8
Lean beef	2 1	Potatoes	24 0
Wheaten flour	2 8	White turnips	54 4

The study of these tables goes to show us that no one food taken alone will supply a right diet. For instance, we should have to eat 6 lbs. of butcher's meat before we could get enough Carbon for our need, while 2 lbs. would be sufficient to supply the necessary Nitrogen. Now, as we only require *a certain* amount of Nitrogen, a good deal would have to be wasted before we could get enough Carbon if we only fed upon meat. And so on all through the tables.

Now let us see what Dr. Russel says :—

'Now what proportion of food is necessary for subsistence? Here is a table in which you will find the proportions :—

Albumenates or Nitrogenous food ...	2½ ozs.
Carbonaceous, or warmth-giving food...	13 ozs.
Salts, or mineral food	½ oz.
Total	16 ozs.

1 lb. of mixed food necessary to meet the daily waste of the human body.'

But Dr. Russell impresses his hearers with the fact that this supply must be of *water-free* food. Food is set before us, containing a large supply of water, and we must make allowance for that. A man in full work will think nothing of making a hearty meal of nearly double the estimated weight, consisting of meat, vegetables and bread, and pudding. But we cannot say he is thereby supplying himself with solid food. At least three-quarters of what he eats is only water, and not *solid food* at all.

But Dr. Russel gives us more tables :—

'*The average diet of men in quietude.*

Albumenates	2½ ozs.
Fat	1 ,,
Carbo-hydrates	12 ,,
Salts...	½ ,,
Total	16 ozs.

'*Diet of a man in moderate work.*

Albumenates	4·587 ozs.
Fats	2·964 ,,
Carbo-hydrates	14·257 ,,
Salts	1·053 ,,
Total water-free food	22·866 ozs.
Say	23 ozs.

'*Diet of a man doing laborious work.*

Albumenates...	6 ozs. to 7 ozs.
Fats	3·5 ,, 4·5 ,,
Carbo-hydrates	16 ,, 18 ,,
Salts	1·2 ,, 1·5 ,,
Total water-free food ...	26·7 ozs. to 31 ozs.

'For harder work than this 35 to 40 ounces of water-free food is needed, or as much as a man can possibly eat, for then it really becomes a race between the stomach and the muscles, and foods like meat, which are rapidly digested and concentrated, become important. The quantity of water also goes up. We have gained this information by means of very costly

national experiments. In the last Arctic Expedition the men were allowed a diet of 35 ounces of food, but that was not enough for the work which had to be performed.

'Sir Robert Christison said of the British Army in the Crimea, that any person could have foretold as a certain consequence, sooner or later, of their dietary, that the British troops would fall into that calamitous state of health which befell them; for they were sent on a diet on which they were living at home doing nothing, into a cold climate, where they had to work very hard indeed. It cost the country a great many lives and much money before the diet was corrected.'

We will take one other authority on this subject—Dr. Chambers:—

'Supposing a man to consume 200 ozs. of victuals daily, the contents should be about—
6 quarts of water,
8 ozs. of animal matter, as cheese, lean meat, eggs,
6 ozs. of fat, oil, or butter,
9 ozs. of sugar or starch,
1 oz. of salt and mineral matter.'

Here we see, again, that about 1½ lbs. of water-free food daily is estimated to be sufficient for a full-grown man doing an ordinary amount of work.

CHAPTER XVI.

COMPARATIVE NUTRITIVE VALUE OF FOOD.

I HAVE heard it stated, or seen it somewhere, that in the days of the future, it is not at all unlikely that our chemists may discover a way of feeding folks by administrations of the primary elements, without making use of those various elements compounded. It will simplify the matter, doubtless, when housewives will only need to go to the various bottles or cans and administer so much and no more of Oxygen, Carbon, Hydrogen, and Nitrogen, like measuring out a dose of physic; but I am not at all sure I wish to believe in such a possibility. What would become of all the little dainty surprises which we women so love to concoct for our dear ones? and then, again, the wee darlings! fancy a birthday without a cake, or a Christmas without a pudding! How in those days people would detest the sight of those same inevitable bottles and cans. It *is* delightful to come to table not knowing quite what niceties are prepared for us. Think a moment what a revolution in social and domestic matters the prophesied coming state of things will bring about. No kitchens! nothing but laboratories. No table appliances, only bottles and spoons! All the cutlers must choose another trade, also the cultivators in general. Well, all this won't come in *our* time, that's one comfort.

But at the same time I think our children get a notion on first learning the different properties of the various foods, that they are to go to Albumencids for an ounce or so of Nitrogenous Foods, and to the Carbonaceous Foods for a certain amount of the warmth-giving, and so on. And they are somewhat disappointed when they discover that these things are not to be procured in an already extracted state, like Liebig's essence of beef.

And this state of things brings us to actual *practical* teaching. I mean the giving the children something to do, as well as something to think about. Let me tell you how *I* should manage here.

First, I should set before them a table such as the following, which is supplied by Dr. Letheby. I should lead them carefully to study it *with me*, and then to make a copy of it themselves.

Table Showing the Nutritive Value of Foods (Letheby).

Substances, 100 parts.	Water.	Fibrine, Albumen, etc.	Starch, Sugar, etc.	Fat.	Salts.
Human Milk	89	3·5	4·2	3·0	0·2
Cow's Milk	86	4·5	5·0	4·1	0·7
Skimmed Milk ...	87	4·5	5·0	2·7	0·7
Butter Milk	87	4·5	5·0	0·5	0·7
Beef and Mutton ...	73	19·0	,,	5·0	2·0
Veal	77	19·0	,,	1·0	0·6
Poultry	74	21·0	,,	3·0	1·2
Bacon	20	0·8	,,	70·0	1·3
Cheese, Cheddar ...	36	29·0	,,	30·0	4·5
,, Skimmed ...	44	45·0	,,	6·0	5·0
Butter	15	,,	,,	83·0	2·0
Eggs	74	14·0	,,	10·5	1·5
White of egg	78	20·0	,,	,,	1·6
Yolk of egg	52	16·0	,,	30·0	1·3
White Fish	78	18·0	,,	3·0	1·2
Salmon	78	17·0	,,	4·0	1·4
Eel	80	10·0	,,	8·0	1·3
Wheat Flour	15	11·0	70·0	2·0	1·7
Barley Meal	15	10·0	70·0	2·4	2·0
Oat Meal	15	12·6	62·0	6·0	3·0
Rye Meal	15	9·0	66·0	2·0	1·8
Indian Meal	14	9·0	65·0	8·0	1·7
Rice	14	7·0	76·0	0·3	0·3
Haricot Beans ...	19	23·0	45·0	3·0	3·6
Peas	13	22·0	58·0	2·0	3·0
Beans	14	24·0	44·0	1·4	3·6
Lentils	14	29·0	44·0	1·5	2·3
Wheat Bread	44	9·0	49·0	1·0	2·3
Rye Bread	48	5·0	46·0	1·0	1·4
Potatoes	74	2·0	23·0	0·2	0·7
Green vegetables ...	86	2·0	4·0	0·5	0·7
Arrowroot	18	,,	82·0	,,	,,

Then, with this table before them, I should set them to work to pick out and put together the foods richest as nutrients, as warmth-giving foods, and as mineral foods. I should allow them to take paper and pen and answer such questions as these:—

'Which foods contain the most water?' 'Which are almost entirely water and starch?' 'Supposing each "part" in the table to stand for one ounce, and supposing also that every man doing a fair share of work requires eight ounces of Nitrogenous Foods to keep up his strength, how much of the following articles must he eat before he obtained this requisite quantity: 1, Potatoes; 2, Cheese; 3, Bread; 4, Cabbage; 5, Lentils; 6, Beef or Mutton.

'A man needs at least twelve ounces of warmth-giving food daily. Show how much albumen he must waste before he could get this supply if he had only veal to live upon?'

It is by such application of the lessons that the active interest of our children must be awakened, and that they will learn that there is some real use in all these tables which we bring before them.

(To be continued.)

—o—

How to Earn the 'Excellent' Grant.

By One of Her Majesty's Inspectors of Schools.

Good reading can only be taught by setting a careful model to your scholars, and by insisting upon entire adherence to it. This involves simultaneous reading, but let that reading be quite quiet; suppress any tendency to shouting; and in order to secure correct

intonation, adopt some such system as the following. Put one good reader in the midst of half a dozen indifferent ones, and then let this group read together after you. Let another group, similarly supported by a scholar with a quicker ear, read the same passage; then another. Then combine a couple of the groups; and eventually you will get the whole class to render passages smoothly and with just emphasis.

The same system will apply to the teaching of recitation. But if simultaneous reading and recitation is left in the hands, or rather in the mouths, of the whole class, without this group instruction there is much risk, either of the reading and recitation falling into an unmeaning cadence, or its proving at the best a very rough reproduction of your model. Let us not, of course, be misunderstood to mean that there should be no individual reading. Of course there should be, and the rest of the class should be on the look-out to correct by show of hands, not only mis-pronunciations, but also provincialisms, mistakes in the use of the aspirate, and misaccentuations.

Writing should be round, bold, and slightly sloped, in the Infant Class and in Standards I. and II. Where copies for slate work are set to these classes, they should be put upon the blackboard, which should be permanently ruled for the purposes of copy-setting. The Education Department urges upon Her Majesty's Inspectors the value of simultaneous writing lessons; that is to say, the writing by the teacher of a copy on the blackboard, to be followed stroke by stroke, turn by turn, loop by loop, by the scholars. In order the more thoroughly to secure such a faithful reproduction of a good model from the very start, the slates, as well as the blackboard should be ruled in sets of three lines, sufficient space being allowed to prevent the heads and tails of the letters meeting one another.

Even in the case of writing in copy-books, I find good blackboard teaching produces the best writing; for the scholars, when copying the head-lines printed in their books, are left too much to themselves, and consequently get into careless or vicious ways of writing, which the teachers afterwards find it hard to eradicate. If copy-books with head-lines are used, most careful supervision should be given, and books should be used in which the introduction of a fresh copy in the middle of the page tends to make the children keep their eyes fixed upon a good model, instead of upon the last line of their own inferior writing.

In some schools I have found the old-fashioned copy-slips used with great advantage in all classes; these certainly have this advantage over head-lines, that they enable the teacher, by having them pushed down after each fresh line has been written, not only to secure a uniform rate of writing, but also the constant observation of a good model.

I have been very urgent during the last year and a half in requiring managers to provide desks, not only for the First Standard, but for Infants. For I find writing vitiated from the very start by infants being taught to write in the most absurd attitudes, such as standing, kneeling against a form, or bending over a slate supported on the knee.

Again, we find in infant classes mischief is done to the writing by making the children write quite too much from memory. Letters and short words are dictated to them, instead of being put upon the board for them to copy.

Spelling, instead of being taught, as it used to be, almost entirely orally, or through transcription from the blackboard, is now almost invariably taught through dictation, the fact being that there is great risk, not only of the writing suffering through constant dictation exercises, but of the spelling deteriorating through the same cause. Dictation is, no doubt, the best *test* of spelling and writing combined; but it should only be an occasional test following upon well-prepared oral lessons in spelling, and careful copies of well-chosen and well-written exercises upon the blackboard.

Arithmetic. Now that mental arithmetic is generally taught in schools, the use of fingers or strokes upon the slates in the First and Second Standards should never be permitted by teachers. Children should be taught addition and subtraction first through the eye by means of the ball-frame, or such other visual aids as Sonnenschein's number pictures, the Kindergarten bead wires, and Farnsworth's domino sheets.

Again we urge upon teachers the adoption of the continental practice of teaching weights and measures by means of the actual weights and measures themselves. Every school should have its scales for *letter* and *parcel weighing*, if not for weighing much heavier weights; and should be further provided with liquid and corn measures, in which corn and water should be actually measured by the teacher and children. This system has produced marvellous results in several schools under our supervision and has appealed so strongly to the parents of the scholars that they affirm that is what they and their children best like in the school course. Exercises of a very useful kind in the measurement of distances can be given in the playground by means of a tape marked with the yards and poles; and in some First Standards the foot and yard measures are used to teach children how to draw the plan of the schoolroom according to scale.

In arithmetic generally, it is most important never to leave a rule until the average child can work a reasonable sense sum in it. Some of the most successful teachers we know effect this by showing the class how to work the problem on the board, then calling up the best arithmetician in the class and getting him to repeat the explanation step by step for his comrades, but not resting satisfied till they have got a child of average capacity to go through it without hesitation before his fellows.

Before turning from arithmetic, we have to point out a very serious mistake in method, of which, we venture to say, a large number of teachers are unconsciously guilty. This has reference to the use of test cards. We do not at all underrate the value of such cards; but they are sold in packets of fifty, and are clearly intended to be used a few at a time, in such a way that the whole class may work them all correctly at such a uniform rate as will secure adequate explanation of their difficulties to each scholar. But what do we in reality find to be the usual mode of procedure? Why, that thirty, forty, or even fifty of these cards are dealt out to a class!

From three to four hundred different sums are thus being worked out by the scholars of one class in a single hour. Now, we ask, how can a teacher correct these sums in the upper standards in the only way in which such correction is of any value? We have known teachers keep a class in a good half-hour in order to attempt to do this, and in the end be obliged

to dismiss them and work on at their slates till after one o'clock. Now, if that teacher had only taken the trouble to put up upon the blackboard two sets of questions taken from such cards, and had then got the scholars to take those sets alternately, she would have had ample time not only to give help to scholars in difficulty, during the lesson, but also at the end of it to have added some valuable comments upon the questions worked; to say nothing of the opportunity thus afforded her of gauging the progress of the *whole* class. This practice of giving a separate card to each scholar in a class is as bad a method as it is to give children a so-called copy-book lesson at which every child pretty nearly is writing a different copy.

As to the value of *Grammar* in educational training, there is a considerable difference of opinion; but under the present code it must be taught in pretty nearly every school. To be made a practical subject of instruction, it should be attacked from as many points of view as possible, and in capable hands furnishes an interesting lesson to scholars. Begin even in the Second Standard with the sentence, and show that this consists of the thing or person spoken of, which is both the subject and the nominative of the sentence, and, in its simplest form, the predicate or verb which states what the subject does.

Make sentences with the noun and verb in the singular and plural, and get children to observe their differences until they are masters of number. Treat sentences from the same point of view in reference to gender. Put up a list of nouns on the blackboard, and get the scholars to supply suitable verbs for each of them; reverse the process with a fresh set of verbs, requiring them to turn them into short sentences by the addition of nouns of their own.

Never supply the definition of nouns and verbs until the scholars are sufficiently conversant with their functions to be ready to give definitions of their own. Then point out where these definitions are faulty, and in the end get them to appreciate the best definition procurable.

Even in this Standard the common provincialism of using nouns in the plural, followed by a verb in the singular can be exposed and corrected, and a beginning thus made of practically applying grammatical rules to assist the choice of language. In the Third Standard the teaching of Grammar through analysis can be readily proceeded with; the adjective, pronoun and adverb being introduced in relation to the functions they perform in a sentence, while the formation by the scholars of simple sentences containing them will teach them to use language more readily and precisely. The same remarks will apply with greater force to the Grammar of Standard IV. Finally, the new requirements in Standards V., VI., and VII., with reference to prefixes and terminations, will give the scholars a desirable insight into the history of our language. Undoubtedly the new Grammar course is a far more intelligently conceived syllabus than the old one.

What we said just now on the subject of teaching scholars to speak correctly leads us to a question which I consider to be at the root of all successful teaching. This is, the cultivation of ready, correct, and adequate answering amongst school children. Undoubtedly this is a difficult matter with children who enter school with a small vocabulary and belong to a nation that is as a rule singularly scant of speech.

But if this difficulty is met at the outset in the Infant Class, and such a conversational method introduced as will be found in Sonnenschien's *Chats with Children*, every day will loosen the scholars' tongues, and the present system of answering in single words or ungrammatical phrases will quickly disappear. One very simple plan for cultivating the faculty of expression is the old game of Russian Scandal. The teacher tells the scholar a story, the latter repeats it to a comrade, and it thus goes round the class; of course, at first with startling variations in the text. These mistakes the teacher notes and calls attention to, amidst a good deal of merriment. It is clear if you can get scholars in this way to speak correctly, writing correctly will be a natural consequence; and while we are on this topic let us say that we know as a fact schools where a letter is written monthly by every scholar, from the Second Standard up. These letters are taken home, and in many instances despatched to friends at a distance, with very happy results. We think there is a moral obligation upon every teacher to teach his scholars how to write letters such as these, which should not be couched in the artificial terms of your model letter, but expressed in the fresh, unaffected speech of childhood. This is true education, for it draws out the higher nature in children, and establishes in the child a good habit which is beyond price.

(To be continued.)

—o—

Lessons in Latin.

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KEY TO EXERCISES.

EXERCISE 77.

A.

1. In the meantime the hollow rocks were giving back thy name to the whole shore, crying out, Oh! Thesus, and as often as I, so often did the place itself call you. The place itself wished to bring assistance to (me) miserable. 2. Let us remember also that justice must be preserved even against the lowest. 3. Cimon never placed a guardian in his gardens lest anyone should be hindered from enjoying those things which each one wished (for). 4. After that these (began) to assemble in large numbers: 'since,' says he, 'you, my son, have fought against the command of the consul, you ought to restore discipline by your punishment.' 5. Sometimes in the army a heavy sedition arose and a part of the soldiers had revolted from the rest and had made for themselves a leader. 6. In the meantime it is announced that the Ambassador had arrived from Rome; to meet whom, messengers were sent by Hannibal, to say that it was not worth while to Hannibal, in such a juncture of affairs, to hear embassies. They not having been admitted, came forthwith to Carthage, but this embassy was also useless. 7. Fear thence dejected the Romans and the wound

and the dangers (severally) increased the fear of the consul, who is said to have been preserved by the assistance of his son still a youth. 8. This youth was called Africanus on account of his illustrious victory over Hannibal and the Carthaginians, with whom is the praise of this war having been brought to an end. 9. The flight of the javelin throwers had been very greatly indulged in, the cavalry brought back the consul into the camp by never yielding in confusion. 10. After that the king made an end of speaking, the ambassadors of Jugurtha answer in a few words 'That Hiempsal had been killed by the Numidians on account of his own savageness: that Adherbal, making war on his own account, after he was overcome, complained because he had been unable to cause an injury: that Jugurtha sought from the Senate, to think no else than what was known in Numantia and not to place the words of an enemy before his (Jugurtha's) own deeds.

B.

1. Tempus erat, vitrea quo primum terra pruina spargitur et tectæ fronde queruntur aves. 2. Metuo ne, dum minuere velim laborem, augeam. 3. Parmenio deterrere regem voluit, quominus medicamentum biberet, quod medicus dare constituerat. 4. Postquam cervice caesa fusus est cruor, in questus et lamenta ruperunt. 5. Extemplo omnium iras permulsit seditionemque compressit. 6. Hanno unus senatum obtestatus est, ne Romanum susciperent bellum; monuisse se ait, ne Hamilcaris filium ad exercitum mitterent; non manes ejus viri quiescere nec inquam, donec sanguinis Barcini quisquam superesset, quietura Romana foedera. 7. Sempronius ad tumultum Numidarum primum omnem equitatum, deinde sex millia peditum, postremo omnes copias avidus certaminis eduxit. 8. Erat forte brumae tempus et nivalis dies: accedebat, quod raptim eductis hominibus atque equis, non capto ante cibo, nihil caloris inerat, et eo acrior afflabat frigoris vis. 9. Ut vero refugientes Numidas insequentes aquam ingressi sunt, tum egressis rigebant omnibus corpora, ut vix armorum tenendorum potentia esset, et fame etiam deficiebant.

EXERCISE 78.

A.

EXTRACT FROM VIRGIL, AENEID V., 485-518.

Forthwith Aeneas invites (them) to contend with the swift arrow, who by chance may wish, and places the rewards; and with a great band he erects a mast from the ship of Serestus; and hangs from the high mast, a swift dove in (or by) a string thrown about (it) at which they may aim their (arrow-) tip. The men have assembled, and a brazen helmet has received the lot thrown down (*i. e.* in) and the first place before all comes out, with a favouring shout, for Hyrtacides (the brother of) Hippocoon: and him next, Mnestheus, the victor in the naval contest, follows; Mnestheus was bound with a green olive. The third was Eurytion, thy brother, O most illustrious Pandarus, thou who formerly, having been ordered to violate a treaty wast the first to hurl thy dart into the midst of the Greeks. And Acestes' (name) sat last at the bottom of the helmet, and he too dared to try his power with the band of youths. Then the men with great strength bend their curved bows, each one for himself, and bring forth the weapons from their quivers. And through the sky the first arrow of the youth Hyrtacides cuts asunder the swift air, his (bow) string twanging, and it comes and is fixed in the wood of the opposing mast. The mast quivered and the frightened bird trembled on its wings, and all things resounded with a great shout. Afterwards the brave Mnestheus stood with bow extended, seeking the heights, and he equally stretched his eyes and his dart. But he, to be pitied, was not able to touch the bird itself with his (arrow) tip, and burst through the knots and flaxen chains (*i.e.* string) by which she, bound on to her foot, was hanging from the lofty mast: she flying, escapes to the South and into the dark clouds. Then Eurytion rapidly now-and-for-some-time holding his darts stretched on his ready bow, called in prayer upon his brother, having already observed the happy bird in the empty sky, and he pierced the dove under the black cloud as she strikes (the air) with her wings, she falls lifeless, and left her life among the heavenly stars, and brings back the inserted arrow as she fell.

B.

1. N. Aeneas, V. Aenea, Ac. Aenean (am), G. and D. Aeneae, Ab. Aenea. 2. 'Velint' is an irreg. verb from 'volo,' 'volui,' 'velle' (no 3rd root), sub. mood, pres. tense, 3rd pers., plur., agreeing with 'qui.' 3. 'Convenerunt.' 4. 1st, a lot; 2nd, the casting a lot; 3rd, the fate. 5. An adj. of I. decl., C. gen., pl. no., acc. case, gov. by prep. ante. 6. N.V. 'loci' or 'loca,' Ac. 'locos' or 'loca,' G. 'locorum,' D.Ab. 'locis.' 7. N. Mnestheus, V. Mnestheu, Acc. Mnesthea, G. Mnesthei, D. Ab. Mnestheo. 8. A verb of the long E conj. from 'torqueo,' 'tors,' 'torquēre,' 'tort.' Ind. M., perf. tense, 2nd p. sing., to agree with 'qui' (=ĕt tu). 9. 'Summus,' 'medius.' 10. N.V. 'arcus,' Ac. 'arcum,' G. 'arcus,' D. 'arcui,' Ab. 'arcu;' pl. N. V. Ac. 'arcus,' G. 'arcuum,' D. Ab. 'arcubus.' 11. 'Postea.' 12. He looked into the depths of space, and as he drew his bows, he directed his eyes toward the bird. 13. N.V. 'ala,' Ac. 'alam,' G.D. 'alae,' Ab. 'ala,' pl. N. V. 'alae,' Ac. 'alas,' G. 'alarum,' D. and Ab. 'alis.' 14. 'Decīd,' 'Decidĕre,' no 3rd R. 15. N. V. 'Exanimis,' e. Ac. 'exanimem,' e. G. 'exanimis,' D. Ab. 'exanimi.' 16. Pr. tense, 'refero,' 'refers,' 'refert,' 'referimus,' 'refertis,' 'referunt.'

17.

Hyrtăcī | dæ ānte ōm | nēs'' ĕx | īt lŏcŭs | Hīppŏcŏ | ōntĭs |
Extrē | mūs gălē | āē''que ī | mā sūb | sēdĭt Ā | cēstēs
Întrēmŭ | īt mā | lūs'' tīmŭ | ītque ĕxtĕrrĭtă | pēnnīs
Illă Nŏ | tōs ăt | que ātră vŏ | lāns'' ĭn | nūbĭlă | fŭgĭt

The diphthongs and vowels, not marked, are elided before the vowels in the succeeding words. Note the caesura in the last line, after the seventh half foot and not after the fifth half.

(*Conclusion of the Lessons.*)

THE CRICKET.

Lively.

1st TREBLE.
2nd TREBLE.
BASS.

1. Scam-per-ing home from our ev' - ning play, Thro' the star - lit mea-dows we quick - ly pass;
2. Gone is the sum - mer so sweet and fair, With its war - bling birds and its bloom-ing flowers; The

KEY A. *Lively.*

1st TREBLE. | m :-.f :m | s :-.f :m | r :—:f | m :r :d | f :—:r | m :d :l₁ | s₁ :—:f₁ | m₁ :—:d |
2nd TREBLE. | d :-.r :d | m :-.r :d | d :—:t₁ | d :t₁ :d | t₁ :—:t₁ | d :d :f₁ | m₁ :—:r₁ | d₁ :—:d |
BASS. | d :-.d :d | d :-.d :d | s₁ :—:s₁ | d₁ :r₁ :m | r₁ :—:s₁ | d₁ :m₁ :f₁ | s₁ :—:s₁ | d₁ :—:d |

Hark to the voice that ca - rols so gay At our ve - ry feet in the dew - y grass.
breath of win - ter is in the chill air, Soon his snows will ban - ish all sum - mer showers.

E.t.

Ho, ho! lit - tle crick-et, why do you sing on, Don't you know that the day is al - most gone?
Ho, ho! lit - tle crick-et, why do you sing on, When he co - vers the earth with his dark cold wing?

f.A.

Chirp, chirp! chirp, chirp! If that is true, I must chirp till dawn.
Chirp, chirp! chirp, chirp! I'll sit on your hearth and chirp till spring.

Lectures on Shakspere's 'King Lear.'

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No. III. Act I., Scenes 2 and 3.

IN Sc. 2 we have Edmund's soliloquy. Edmund is the illegitimate son of the Earl of Gloster, and, being an ambitious youth, is determined to overcome by fraud some of the disadvantages of his birth. The difficulties of his position he confronts boldly—'Nature, thou art my Goddess.' This is, perhaps, an intimation that he intends to trust to his own natural shrewdness for advancement in the world, but the mention of Nature is suggested, no doubt, by the fact of his being a 'natural' son. Wherefore should he 'stand in the plague of custom,' that is, submit tamely to the plagues and injustice of custom in such a matter, by thinking any worse of himself on account of his birth? This expression 'to stand in the plague' is evidently borrowed from a passage in Prayer Book version of the Psalms (Ps. xxxviii. 17), in which Jerome (who wrote the Vulgate) did his best to grapple with a not very intelligible passage of the Hebrew original. The phrase in English is quite an unusual one. *The curiosity of nations* means the idle, nice distinction of the world, in favour of the elder born. *Curiosity*, in the sense of 'critical scrutiny' occurred in Sc. 1, line 5. In describing himself as *some twelve or fourteen moonshines lag of a brother*, Edmund means that he is younger than his brother Edgar by as many lunar months. But why should he mention his age, when he owes his inferiority, not to the fact of his being a younger son, but to being born out of wedlock? The fact is, that he is inveighing against two things, viz., the tyranny of custom in respect of—(1) illegitimate children; (2) younger brothers, and while complaining of the injustice done him by his own 'bar sinister,' he indulges in some disparaging remarks on the subject of primogeniture. The outcome of his reflections is summed up in the line—

> 'Legitimate Edgar, I must have your land.'

Among the grammatical *notanda* of this speech we may mention the abbreviated participle *compact* = put together; the verb *top* = 'overtop,' 'surpass;' and the redundant use of *that* in *For that*. The last expression will need, perhaps, a few words of explanation. In early writers we find combinations like *After that, before that, for that*, &c., where we should now write *after, before, for*, &c., without any such superfluous addition. The reader may perhaps recollect the passage in the New Testament:

> 'For *before that* certain came from James, he did eat with the Gentiles.'

and he may possibly have heard the emphasis wrongly placed on the *that*. How did this *that* get into use? It is well enough to point out that the word is redundant, but we ought to be in possession of some sort of a theory as to how it came there.

The explanation is, probably, that there were in Anglo-Saxon certain expressions,* like the French *parceque*, in which the *ce* is demonstrative and the *que* relative, of which a literal translation would be 'For that that,' 'Before that that,' &c., and the *that* which is still found after the words *before, for*, &c., represents one of these *that's*, the other having disappeared.

Next enters Gloster, his mind full of misgivings with regard to Lear's abdication. The *King's power*, he reflects, is now *subscribed*, that is, his army is surrendered, he himself is *confined to exhibition*, this is, restricted to an allowance, and all these changes are *done upon the gad*, that is, on the spur of the moment. This meaning of *exhibition* still survives in one or two phrases. The successful student gets an 'exhibition' at the University, which is, in fact, an allowance; and the practitioner who gives you a dose of calomel is said, in medical jargon, to 'exhibit' mercury. *Gad* has nothing to do with the gadfly, but means some sort of a bar or implement of iron, and to *act upon the gad* means something like 'striking while the iron is hot.'

Edmund now commences to put into execution the vile scheme he has concocted against his brother. He pretends to be reading a letter from Edgar,—a letter that he has, however, written himself,—and by pretending to hide it away in great haste, excites his father's curiosity. Asked what he is reading, he replies 'Nothing,' to which Gloster rejoins 'What needed then that terrible dispatch of it into your pocket?' By *terrible dispatch* is meant the hasty, terrified act of thrusting it away, and *terrible*, an epithet of that which *causes* fear, is here used to denote an act *accompanied* by that feeling. So, in King Richard II. (Act III. Sc. 3) we read—

> 'To watch the *fearful bending* of thy knee,'

a passage which supposes the knee to be bent in fear, but not 'fearfully bent.' Gloster's mention of spectacles may have suggested the thought 'When were spectacles invented?' The idea of these useful appliances is frequently ascribed to Roger Bacon, but it was probably brought to completion by the Florentine Armati. The invention had become common by the end of the thirteenth century.

Edmund is in no hurry to show the paper to his father. On the contrary, he pretends hesitation, and intimates that he is in danger of giving offence, either by keeping back the letter or handing it over for perusal. When he does part with it he still pretends to offer an excuse for his brother, alleging that Edgar had but written it *for an essay or taste* of his virtue. Some of the copies read *assay or test*, and this is not surprising, for *assay* and *essay* are etymologically related, as also *taste* and *test*. The terms *essay* and *taste*, says Malone, 'are both from royal tables.' He alludes to the fact that Kings employed servants to taste their food, for fear of its containing poison. In the letter we find '*the best of our time*' put for 'the best time of our life' and *tyranny who sways* for *tyranny which sways*, that is, 'a tyrant who exercises sway.' Perhaps this is the first time that the student has met with *who* for *which*. But Shakspere so wrote more than once, and *which*, it should be remembered, was established as the neuter relative at a comparatively recent period, previous to which its place was frequently occupied by *who*, thus—

> 'Her eyelids *who* like sluices stopped.'
> *Venus and Adonis.*

Aged tyranny sways, says the writer of the letter, *not as it hath power, but as it is suffered*. This may

* *i. e.*, The expressions *For thám the, ær thám the*, &c.

be paraphrased—'An aged tyrant bears rule, less by his own power than owing to the forbearance of his subjects. *Sleep till I waked him* is a Euphemism for 'meet his death,' as though even the man who could be base enough to desire a parent's death were yet unable to put the wish in words. *Closet* here means 'a private room,' and *character* (from the Greek) means 'handwriting.'

Edmund remarks '*I durst swear it were his.*' How often *durst* is employed erroneously for *dare!* 'Swim across John—I durst not.' To some ears, perhaps, this sounds correct, but it is not so in reality, for *durst* is a past tense only, and it is only when speaking of what has already taken place that we can properly say *I durst.*

Gloster enquires whether Edgar has ever 'sounded' his brother before on the subject of their father. Edmund replies with an appearance of candour that he has not done so, but then he has often expressed an opinion that a father in his dotage should be as a ward to a son in the prime of life. *Sons at perfect age* is an instance of the 'absolute' construction (which, by the way, was the dative in Old English), and after *sons* we must understand the participle *being*. Edmund still pretends to advise his father not to act hastily. In the next few lines the metaphors come thick and fast. If the old man will wait for better evidence, he will, says Edmund, '*run a certain course,*' if he attacks Edgar and is mistaken, he will '*make a great gap*' in his own honour; and '*shake in pieces the heart of*' Edgar's obedience. Put into more familiar language this seems to mean (1) that he will take a safe course; (2) that he will lower the honourable estimation in which he himself is held, and (3) that he will cause Edgar's obedience to cease entirely. Edmund still urges *He hath writ this to feel my affection to 'your honour'* (a strange mode of addressing a father!) *and to no other pretence of danger, i. e.,* 'with no dangerous intention.' He suggests, however, that he should talk to his brother in his father's hearing, so that the old man may have his doubts satisfied by *an auricular assurance,* that is, by the evidence of his own ears. Old Gloster is eager to know the worst, for suspense is killing. '*Wind me into him*' means 'I pray you get into his confidence in some roundabout fashion.' Notice that *wind* does not govern *me,* but that *me* is an instance of that curious (Dative) use of the pronoun which appears in 'Rob *me* the exchequer,' and 'A Jew ate *me* a whole ham of bacon,' and which the Latin grammar calls the 'Ethic Dative.' '*I would unstate myself,*' continues the deluded Gloster '*to be in a due resolution.*' This means 'I would divest myself of my dignity in order to be certain of the truth.' Of course *resolution* has nothing to do with *determination.* Malone quotes a passage from Beaumont and Fletcher in which '*I am resolved*' means 'I am satisfied.' Edmund promises to *convey* the business at the earliest opportunity.

While waiting for more certain evidence of his son's guilt Gloster lets his mind run upon all manner of calamities, which he connects, after the fashion of the time, with some recent eclipses of the sun and moon. *Natural philosophy* (this is what he means by *the wisdom of nature*) may explain them away, but the result, he thinks, proves the truth of the theory. '*We have seen,*' he says, '*the best of our time,*' that is 'our best days are over.' '*This villain of mine*' (my undutiful son) '*is in the prediction.*' What prediction? The speaker's mind is running upon the predictions of general wickedness and universal calamity supposed to be contained in certain chapters of the New Testament (St. Matthew x., 21, and St. Luke xxi., 16—25). He can scarcely have believed that his son was alluded to individually, though commentators in more recent times have found a corner in the prophetical writings for most villains of renown. When Gloster is out of hearing Edmund criticises his father's ideas in a tone of common sense scepticism, not unmixed with humour, the pithiest remark of all being his concluding observation on the circumstances of his own nativity. But why should the play concern itself with these popular beliefs? Why should our interest be diverted from Lear and his daughters to this 'foppery' (*i. e.,* folly) of the world, which chooses to think of men's actions as influenced by the planets? Well, it may here be observed, that Shakspere often takes occasion in his plays to satirise, *en passant,* some prevailing folly. Thus, in 'The Tempest' he ridicules the lying disposition of travellers; and in 'As you like it,' the fantastic humour of courtiers. A little local colouring, or a few well-chosen references to current events, have at all times found a place in scenic representations, though, perhaps, at the present day, they are more often met with in comedy and burlesque than in serious pieces or in tragedy.

By *treachers* is here meant 'traitors'—men whose conduct is denoted by the abstract noun *treachery.* By *spherical predominance* is meant 'the predominance of some star (or sphere),' and *enforced obedience of planetary influence* is equivalent to 'being obliged to obey the influence of the planets.' Here *of* denotes the object towards which the obedience is directed. *Divine thrusting on* is an un-metaphorical expression for 'Divine impulse or instigation.'

In the ensuing dialogue there are some rather difficult expressions. In *my cue is villainous melancholy, cue* means 'the part which I am to act.' *Dissolutions of ancient amities* means 'the breaking up of old-standing friendships,' and *needless diffidences,* 'instances of needless distrust.' Here *diffidence* means 'distrust,' not, as generally, of oneself, but of others. *Dissipations of cohorts* is a Latin-sounding expression for the 'disbandment of armies.' *Nuptial breaches* are 'breaches of the marriage tie.' *A sectary astronomical* means 'a student of astronomy' (here *astrology*), and *allay with the mischief of your person* = 'be pacified by your destruction.' In *a continent forbearance, continent* means 'patient.' *On whose foolish honesty my practices ride easy* = 'over whose unsuspecting integrity my crafty designs obtain an easy ascendancy.' *That I can fashion fit* means 'that I can make to suit my purpose.'

Enter Edgar. '*Pat he comes,*' says Edmund, '*like the catastrophe of the old comedy.*' Here the author ridicules the awkward conclusions of some of the older plays, in which the characters make their entry inartistically, and just when the poet wants them on the stage. On the words *fa, sol, la, mi,* much ingenuity has been expended. The commentators seem to have regarded the idea of a man's humming a few meaningless syllables as much too simple, and have set themselves to work to analyse the sequence of tones which these syllables stand for. Since *fa, sol, la, mi,* in the

modern scale, would form a very disagreeable phrase,* they explain that Edmund, speaking of portents, compares the dislocation of events to the unnatural and offensive sound produced by singing these four notes in succession. Whether this be probable or not we leave the student to decide. Twice, at least, we meet with an adjective placed after its noun, viz., in '*a sectary astronomical*' and '*a brother noble.*' The expression *succeed unhappily* (turn out unfortunately) reminds us that *success*, like *fortune*, was once a neutral word, depending for its meaning on a qualifying adjective, as 'bad success,' 'good fortune,' &c. In *from whence*, the *from* is redundant. The adverb *anon* is from the A. S. *on an*, literally 'in one (moment),' though the Anglo-Saxon meaning is not 'in a moment,' but 'once for all.'

There is not much to notice in Scene 3. *By day and night* is possibly a form of asseveration. *That sets us all at odds*, means 'that causes us all to quarrel.' In *himself upbraids us* we have the emphatic pronoun without the personal pronoun which usually precedes it. *The fault of it I'll answer* = 'I will be answerable for the fault of it.' Compare '*Answer my life my judgment*' (Sc. 1, 142). *I'd have it come to question* = 'I should like the matter to be enquired into.' *Idle old man*—here *idle* = foolish. Compare '*an idle and fond bondage*' (Sc. 2, 43). *Manage those authorities* = 'wield that authority,' or 'exercise those rights.' *With checks as flatteries*—supply *well as* after *as*. When they are seen abused = 'when they (the flatteries) are seen (to be) abused.' The sentiment is 'when persuasion fails, compulsion must be employed.' *Advise* = 'warn' or 'caution.' *Breed from hence occasions* = get from this opportunities (of speaking). The Latin word *occasio* means opportunity. *To hold my course* means 'to act in the same manner as myself.' The emphasis should fall on *my*.

(To be continued.)

Easy Steps in Trigonometry.

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ANSWERS AND HINTS TO SOLUTIONS.

CHAPTER III.

1. From D, draw DG, DH, at right angles to b and c respectively; then $\frac{DC}{DG}$ = cosec C, and $\frac{DB}{DH}$ or $\frac{DC}{DH}$ = cosec B. ∴ DG cosec C = DH cosec B, or $\frac{DG}{DH}$ or $\frac{\beta}{\gamma} = \frac{\text{cosec B}}{\text{cosec C}}$ or $\frac{\beta}{\gamma} = \frac{\sin C}{\sin B}$ &c.

2. Let AD and BE bisect the angles A and B, and from P any point in AD draw perpendiculars β, γ to b and c. Then $\beta = \gamma$, or $\beta - \gamma = 0$, is the equation to AD. Similarly $\gamma - \alpha = 0$ in the equation to BE, and $\beta - \gamma + \gamma - \alpha = 0$, or $\beta - \alpha = 0$ is the equation to some line, passing through the intersection of AD and BE, but $\beta - \alpha = 0$ is the line which bisects the angle C. Hence the theorem.

3. As in 1 draw DG, DH, ∴ $\frac{DC}{DG}$ = cosec C, and $\frac{DB}{DH}$ = cosec β.

∴ DG cosec C = 2 DH cosec B. ∴ $\frac{DG}{DH}$ or $\frac{\beta}{\gamma} = \frac{2 \text{ cosec B}}{\text{cosec C}} = \frac{2 \sin C}{\sin B}$

4. (i.) ED = $\frac{a}{2}$ sin C. (ii.) EC = $\frac{a}{2}$ cos C. (iii.) AE = b − $\frac{a}{2}$ cos C. (iv.) EF = AE sin A = $\left(b - \frac{a}{2} \cos C\right) \sin A$ = $\frac{1}{2}$ (2 b sin A − a cos C sin A).

5. From E draw EG perpendicular to a. EG = EC sin C = $\frac{a}{2}$ cos C sin C. $\frac{\alpha}{\gamma} = \frac{EG}{EF} = \frac{\frac{a}{2} \cos C \sin C}{\frac{1}{2}(2b \sin A - a \cos C \sin C)}$.

or α (2 b sin A − a cos C sin C) = γ a cos C sin C.

6. AD = c sin B, or b sin C.

∴ $\frac{\sin B}{b} = \frac{\sin C}{c}$.

Draw CF perpendicular to AB, and we get what we want.

7. a = BD + DC, and BD = c cos B, &c.

8. The other expressions are b = a cos C + c cos A, and c = a cos B + b cos A, hence the theorem is plain.

9. Cos B = $\frac{a^2 + c^2 - b^2}{2ac}$ and cos C = $\frac{a^2 + b^2 - c^2}{2ab}$; in which it will be noticed that the side opposite the angle is absent from the denominator, and that its square is subtracted in the numerator.

10. Draw a triangle CAB, and from C draw CD perpendicular to AB. Then $CB^2 = CA^2 + AB^2 - 2$ AD, AB, or $a^2 = b^2 + c^2 - 2$ AD c, but AD = b cos C, hence, &c.

11. Proceed as in par. 46.

12. Let BAC be a right angled triangle, right angled at C, and let BC = 3 and AC = 4.

∴ tan BAC = $\frac{3}{4}$ or A = $\tan^{-1}\frac{3}{4}$. AB = $\sqrt{9 + 16}$ or 5.

∴ $\sin \tan^{-1}\frac{3}{4} = \frac{3}{5}$, $\cos \tan^{-1}\frac{3}{4} = \frac{4}{5}$, &c.

13. See figures to 12. Angle ABC or B = $\sin^{-1}\frac{4}{5}$, and cos B = $\frac{3}{5}$ ∴ vers $\sin^{-1}\frac{4}{5} = 1 - \frac{3}{5}$ or $\frac{2}{5}$.

14. This question, as printed, is impossible; since the cosine cannot be greater than 1, let us change $\cot^{-1}\frac{3}{4}$ into $\cot^{-1}\frac{4}{3}$.

∴ $\tan \cot^{-1}\frac{4}{3} = \frac{3}{4}$, and $\sin \cos^{-1}\frac{3}{4}$ (drawing a figure) is $\frac{\sqrt{16 - 9}}{4}$ or $\frac{\sqrt{7}}{4}$

15. Let the angle contain x angular units.

$\cos x = \sqrt{3} \sin x$.
$\cos^2 x = 3 \sin^2 x$.
$1 - \sin^2 x = 3 \sin^2 x$
$4 \sin^2 x = 1$
$\sin x = \frac{1}{2}$
or, $x = 30^\circ$

Hence draw the angle as in par. 46, or describe an equilateral triangle and bisect an angle.

16. Sec $x = \sqrt{2} \tan x$
$\sec^2 x = 2 \tan^2 x$
$1 + \tan^2 x = 2 \tan^2 x$
$\tan^2 x = 1$
$\tan x = 1$
$x = 45^\circ$. Hence bisect a right angle.

17. Let AD be the altitude, but AD = b sin C. Hence, &c.

18. $\frac{1}{2}$ b c sin A and $\frac{1}{2}$ c a sin B.

19. The straight lines OA, OB, OC, divide the triangle into three triangles, the sum of whose areas is $\frac{1}{2}$ r a + $\frac{1}{2}$ r b + $\frac{1}{2}$ r c, or $\frac{1}{2}$ r (a + b + c), but the area of the triangle is $\frac{1}{2}$ b c sin A, hence, &c.

20. R = $\frac{a}{2}$ cosec A.

21. Draw the angle. The perpendicular will be found to be 5. Hence, $\sin \cos^{-1}\frac{12}{13} = \frac{5}{13}$.

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* Dr. Burney's note on this passage is amusing. He says 'The monkish writers on music say "*mi* contra *fa* est diabolus."'

22. $\text{Cos}\sin^{-1}\frac{3}{5}=\frac{4}{5}$

$\text{Sin}\tan^{-1}\frac{4}{5}=\frac{4}{\sqrt{16+25}}$ &c.

23. Of the angle whose sin is x, the perpendicular is x, the hypotenuse, 1 and the base $\sqrt{1-x^2}$. Hence $\cos\sin^{-1}x=\frac{\sqrt{1-x^2}}{1}$ and of the angle whose sin is $\sqrt{1-x^2}$, the perpendicular is $\sqrt{1-x^2}$, the hypotenuse 1, and the base x.

$\therefore \cos\sin^{-1}\sqrt{1-x^2}=\frac{x}{1}$ or x.

24. Of the angle whose cos is x, the sec is $\frac{1}{x}$ Therefore $\cos^{-1}x=\sec^{-1}\frac{1}{x}$.

25. The angle $\tan^{-1}1$ is 45°. $\text{Sin}\,45°=\frac{1}{\sqrt{2}}$, and of the angle whose cotangent is $\frac{1}{\sqrt{2}}$, the base is 1, the perpendicular is $\sqrt{2}$, and the hypotenuse $\sqrt{3}$. Hence the angle can be drawn.

CHAPTER IV.

1. This can be done from first principles, as in par. 57, or analytically, thus :—

$$\text{Cot}\,2x=\frac{1}{\tan 2x}=\frac{1-\tan^2 x}{2\tan x}$$
$$=\frac{1-\frac{1}{\cot^2 x}}{\frac{2}{\cot x}}=\frac{\cot^2 x-1}{2\cot x}$$

2. $\text{Sin}\,x=\frac{3}{5}\quad \cos x=\frac{4}{5}$
$\text{Sin}\,2x=2\times\frac{3}{5}\times\frac{4}{5}=\frac{24}{25}$

3. $\text{Cos}\,x=\frac{5}{13}\quad \sin x=\frac{12}{13}$
$\text{Cos}^2x=\frac{25}{169}-\frac{144}{169}=-\frac{119}{169}$
The meaning of this negative sign will be explained in Chapter VII.

4. Resolve into factors. Eliminate by Formula 1, and apply Formula 7.

5. $\frac{24}{7}=\frac{\tan x}{1-\tan^2 x}$
$24-24\tan^2 x=7\tan x$
$24\tan^2 x+7\tan x-24=0$
$\text{or}\ \tan x=\frac{\pm\sqrt{2353}-7}{24}$

6. Sec 5. The hypotenuse of the angle whose tan is $\frac{\sqrt{2353}-7}{24}$ is $\sqrt{2352+49-14\sqrt{2352}+576}$

$\therefore$ the sin of the angle is $\frac{\sqrt{2353}-7}{\sqrt{2978-14\sqrt{2353}}}$

7. $\text{Cosec}\,2x=\frac{1}{\sin 2x}=\frac{1}{2\sin x\cos x}=\frac{1}{2}\operatorname{cosec}x\sec x$

8. Let ABC be an equilateral triangle, and let AD be the perpendicular, on BC, then sin ABD or sin 60°
$=\frac{AD}{AB}=\frac{2\,AD\,.\,BD}{4\,BD\,.\,BD}=\frac{2\,AD.}{AB}\frac{BD}{AB}$, &c.

9. $\text{Sin}\,2x=2\sin x\cos x$
$=\frac{2\cos x}{\sin x\ \operatorname{cosec}^2 x}$
$=\frac{2\cot x}{\cot^2 x+1}$
$=\frac{1}{\frac{2\cot^2 x-(\cot^2 x-1)}{2\cot x}}$
$=\frac{1}{\cot x-\cot 2x}$ See Question 1.

10. Use result found in Question 1 of this chapter to reduce cot 2x. Apply Formulas 4, 5, 1, and 6.
11. Apply Formula 8. Reduce to a single fraction, collect, and apply Formulas 4 and 7, and reciprocal.
12. Apply Formulas 4, 5, 1, 6.
13. Apply Formulas 5, 4, 7, 6.
14. Apply reciprocals and Formulas 5 and 4, collect, &c.
15. $\text{Tan}\,2\tan^{-1}\frac{a}{b}=\frac{2\frac{a}{b}}{1-\frac{a^2}{b^2}}=\frac{2ab}{b^2-a^2}$

$\therefore 2\tan^{-1}\frac{a}{b}=\tan^{-1}\frac{2ab}{b^2-a^2}$

16. $\text{Sin}\,x=a$; $\cos x=\sqrt{1-a^2}$
Apply Formula 7. $\underline{\text{Cos}\,2x=1-2a^2}$. Ans.

17. $a=\frac{2\tan x}{1-\tan^2 x}$
$\therefore a-a\tan^2 x=2\tan x-$
$\tan^2 x+\frac{2\tan x}{a}+\left(\frac{1}{a}\right)^2=1+\frac{1}{a^2}=\frac{a^2+1}{a^2}$
$\therefore \tan x=\frac{-1\pm\sqrt{a^2+1}}{a}$

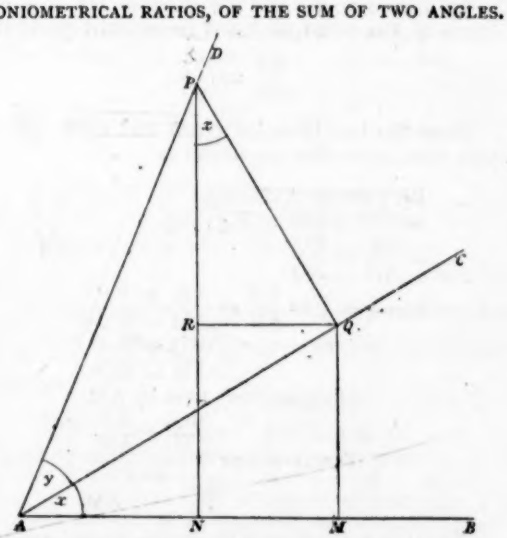
18. Apply Formulas 8, 4, and 9, and multiply numerator and denominator by cos x.
19. Reduce to ratio of single angle, and apply Formula 9.
20. We must read $\frac{12}{5}$ for $\frac{5}{12}$. Of the angle whose cot is $\frac{12}{5}$, the tan is $\frac{5}{12}$. And of the angle whose cos is $\frac{5}{12}$ the perpendicular is $\sqrt{144-25}$ or $\sqrt{119}$.

$\therefore \text{Sin}\cos^{-1}\frac{5}{12}=\frac{\sqrt{119}}{12}$ or $\sin\cos^{-1}\tan\cot^{-1}\frac{12}{5}=\frac{\sqrt{119}}{12}$

21. Of the angle whose cosine is $\frac{3}{5}$, the perpendicular is 4, and $\therefore$ its sine is $\frac{4}{5}$.
$\therefore \text{Cos}\,2\cos^{-1}\frac{3}{5}=\frac{9}{25}-\frac{16}{25}$ or $-\frac{7}{25}$
$\therefore \text{vers}\,2\cos^{-1}\frac{3}{5}=1-(-\frac{7}{25})$ or $\frac{32}{25}$
22. Covers $2\cot^{-1}\frac{4}{3}=1-\sin 2\cot^{-1}\frac{4}{3}$. Of the angle whose cot is $\frac{4}{3}$, the hypotenuse is 5, the sin is $\frac{3}{5}$, and the cos is $\frac{4}{5}$.
$\therefore$ covers $2\cot^{-1}\frac{4}{3}=\frac{1}{25}$.
23. Apply Formulas 9, 10, 4, and 3.
24. The equation can easily be reduced to $\cos 2\theta=2\sin 2\theta$
$\therefore 2\theta=\sin^{-1}\frac{1}{\sqrt{5}}$
25. $\text{Cos}\,\theta+2\sin\theta=\sqrt{5}$
$4\sin^2\theta=5+\cos^2\theta-2\sqrt{5}\cos\theta$
$4-4\cos^2\theta=5+\cos^2\theta-2\sqrt{5}\cos\theta.$
$5\cos^2\theta+2\sqrt{5}\cos\theta-1=0$
$\therefore \cos\theta=\frac{1}{\sqrt{5}}$
$\therefore \sin\theta=\frac{2}{\sqrt{5}}$
and $\tan\theta=2$.

CHAPTER V.

GONIOMETRICAL RATIOS, OF THE SUM OF TWO ANGLES.



61. Let BAC be a small angle containing x angular units, and let CAD contain y of the same unit, then BAD contains $x+y$, angular units.

In DA (the last line we drew) take any point P and draw perpendiculars PN, PQ on BA, CA respectively.

From Q draw QM, QR perpendicular to AB and PN respectively.

We must first prove that QPR contains x angular units, or is = BAC.

$$QPR = 90^\circ - PQR = RQA = QAB = x.$$

$$\text{Sin } \overline{x+y} = \frac{PN}{AP} = \frac{RN}{AP} + \frac{PR}{AP}$$

$$= \frac{QM}{AP} + \frac{PR}{AP}$$

Since QM = RN.

Now we want to find some side of two right-angled triangles containing QM and AP which is common to them, and also some side common to two other right-angled triangles, containing PR and AP, and these lines are evidently AQ and PQ respectively. Hence:—

$$\text{Sin } \overline{x+y} = \frac{QM}{AQ}\frac{AQ}{AP} + \frac{PR}{PQ}\frac{PQ}{AP}$$

$$= \text{Sin } x \text{ Cos } y + \text{Cos } x \text{ Sin } y.$$

Form. 11.

62. Using same figure.

$$\text{Cos } \overline{x+y} = \frac{AN}{AP} = \frac{AM}{AP} - \frac{NM}{AP}$$

$$= \frac{AM}{AP} - \frac{RQ}{AP}$$

Since RQ = NM.

Again we must multiply and divide as before by AQ and PQ.

$$\text{Cos } \overline{x+y} = \frac{AM}{AQ}\frac{AQ}{AP} - \frac{RQ}{PQ}\frac{PQ}{AP}$$

$$= \text{Cos } x \cos y - \sin x \sin y.$$

Form 12.

63. Before we can find the value of tan $\overline{x+y}$ in terms of the ratios of x and y—we must prove that

$$\frac{RP}{AM} = \frac{PQ}{AQ}$$

Draw the two triangles QAM and QPR side by side, then, since they are similar:

$$PR : PQ = AM : AQ.$$

$$\text{and } PR : AM = PQ : AQ.$$

$$\text{or } \frac{PR}{AM} = \frac{PQ}{AQ}$$

$$\text{Tan } \overline{x+y} = \frac{PN}{AN} = \frac{NR + RP}{AM - NM}$$

$$= \frac{MQ + RP}{AM - RQ}$$

Dividing every term by AM

$$\text{Tan } \overline{x+y} = \frac{\frac{MQ}{AM} + \frac{RP}{AM}}{1 - \frac{RQ}{AM}}$$

We must multiply and divide the second term of the denominator by RP, to obtain the expression which we have proved $= \frac{PQ}{AQ}$

$$\therefore \text{Tan } \overline{x+y} = \frac{\frac{MQ}{AM} + \frac{PQ}{AQ}}{1 - \frac{RQ}{RP}\frac{PQ}{AQ}}$$

$$= \frac{\text{Tan } x + \tan y}{1 - \tan x \tan y}$$

Form. 13.

64. By writing x for y we obtain the expressions for $\overline{x+x}$ or $2x$, which will be found to correspond with those expressions found in pars. 55, 56, 57.

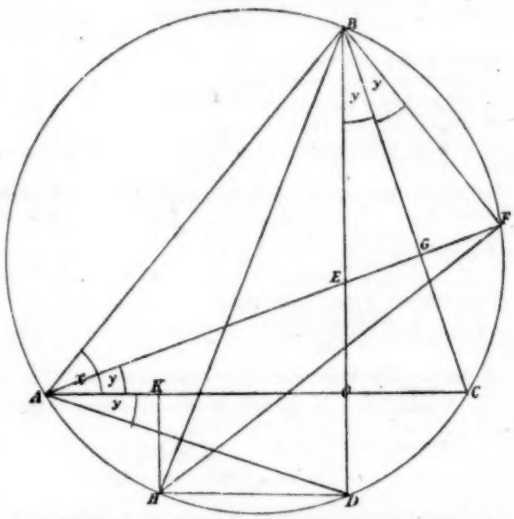
65. The tangent of two angles can be found analytically from the sine and cosine of the same two angles, thus. Using Formulas 4, 11, and 12.

$$\text{Tan } \overline{x+y} = \frac{\sin \overline{x+y}}{\cos x + y} = \frac{\sin x \cos y + \cos x \sin y}{\cos x \cos y - \sin x \sin y}$$

dividing every term of this fraction by cos x cos y, we have:

$$\text{Tan } \overline{x+y} = \frac{\frac{\sin x \cos y}{\cos x \cos y} + \frac{\cos x \sin y}{\cos x \cos y}}{1 - \frac{\sin x \sin y}{\cos x \cos y}}$$

$$= \frac{\tan x + \tan y}{1 - \tan x \tan y.}$$



66. Here is another proof of these theorems. Let BADC be a circle, and let BD and AC cut one another at right angles in O. Let OB be greater than OD, and from OB cut off OE = OD. Join AE and produce it to meet the circumference in F. Draw the diameter BH, and from H draw HK perpendicular to AC. Join other points as in figure.

The triangles AOD and AOE are evidently equal in every respect.

∴ The angle DAC = CAF, but DBC = DAC and CBF = CAF by Euclid III. 21.

Let these 4 angles contain y angular units.

Let BAC or BDC, which is equal to BAC (by Euclid III. 21), contain x similar units. Then BAD or BHD contains $\overline{x+y}$ units and BAF or BHF contains $\overline{x-y}$ units.

$$\text{Sin } \overline{x+y} = \frac{BD}{\text{diam.}}$$

Let us call the diam. 1. Then BD represents the sine of $x + y$, or in other words, referred to the diameter, the chord opposite to an angle at the circumference of a circle is the sine of the angle.

ADB $= 90^\circ - y \therefore$ AB $=$ sin $(90^\circ - y)$ or cos y.
ABD $= 90^\circ - x \therefore$ AD $=$ sin $(90^\circ - x)$ or cos x.

Since a perpendicular from the centre on HD would also be perpendicular to AC—the angles BOA and BDH (Euclid III., 31) being right angles—and bisect both the lines (Euclid III. 2), hence AK = OC.

67. $$\text{Sin } \overline{x+y} = \text{BD} = \text{BO} + \text{OD}$$
$$= \frac{\text{BO}}{\text{AB}}\,\text{AB} + \frac{\text{OD}}{\text{AD}}\,\text{AD}$$
$$= \sin x \cos y + \sin y \cos x.$$

68. $$\text{Cos } \overline{x+y} = \text{HD} = \text{AO} - \text{AK} = \text{AO} - \text{OC}$$
$$= \frac{\text{AO}}{\text{AB}}\,\text{AB} - \frac{\text{OC}}{\text{CB}}\,\text{CB}$$
$$= \cos x \cos y - \sin y \sin x.$$

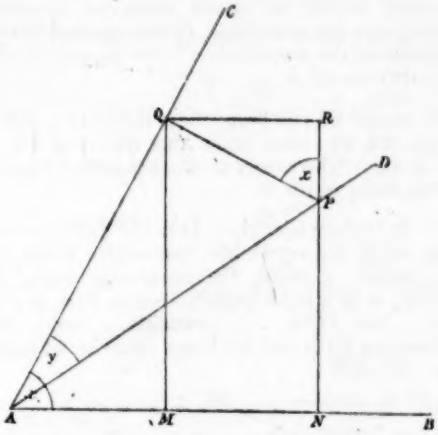
69. $$\text{Tan } \overline{x+y} = \frac{\text{BD}}{\text{HD}} = \frac{\text{BO} + \text{OD}}{\text{AO} - \text{AK}}$$
$$= \frac{\frac{\text{BO}}{\text{AO}} + \frac{\text{OD}}{\text{AO}}}{1 - \frac{\text{BO}}{\text{AO}}\,\frac{\text{OC}}{\text{BO}}}$$
$$= \frac{\tan x + \tan y}{1 - \tan y \tan x}.$$

70. EXAMINATION AND EXAMPLES.—V.

1. Prove $\tan x + \tan y = \dfrac{\sin (x+y)}{\cos x \cos y}$
2. Prove $\cot x - \tan y = \dfrac{\cos (x+y)}{\sin x \cos y}$
3. In Fig. of par. 66, join DF, and draw a perpendicular on it from C, and prove $\sin 2y = 2 \sin y \cos y$.
4. In Fig. of par. 66, what line would represent cos $\overline{x-y}$?
5. In Fig. of par. 66, prove ABC $= 90^\circ - (x - y)$
6. In Fig. of par. 66, prove HF = AC.
7. In Fig. of par. 66, draw the line which would represent cos $2y$.
8. If $\sin x = \frac{3}{5}$, and $\tan y = \frac{5}{12}$, find sin $\overline{x+y}$.
9. Tan $x = \frac{3}{4}$, and $\tan y = \frac{3}{4}$, find tan $\overline{x+y}$.
10. Prove $\tan^{-1}\frac{1}{2} + \tan^{-1}\frac{1}{3} = \tan^{-1} 1$.
11. If $\sin x = \frac{7}{25}$, and $\cos y = \frac{12}{13}$, find cos $\overline{x+y}$.
12. If $\tan 2x = \frac{336}{527}$, find sin x.
13. Prove $\cot \overline{A+B} + \tan A = \dfrac{\cos B}{\cos A}\,\dfrac{1}{\sin (A+B)}$
14. Prove $\sin 4A = 4 \sin A \cos A \cos 2A$.
15. Prove $1 + \sin 2A = (\sin A + \cos A)^2$
16. Hence prove $\sqrt{1 + \sin 2A} + \sqrt{1 - \sin 2A} = 2 \sin A$
17. If m tan B = n tan A
prove $\dfrac{m+n}{n} = \dfrac{\sin \overline{A+B}}{\cos A \sin B}$
18. If m cot x = n tan y
prove $\dfrac{n-m}{m} = \dfrac{\cos (x+y)}{\sin x \sin y}$
19. Prove $\sin \overline{45^\circ + x} = \dfrac{\sin x + \cos x}{\sqrt{2}}$
20. Prove $\sin \overline{x + 2x} = 3 \sin x - 4 \sin^3 x$.
21. If $\sin x = \frac{1}{2}$, prove $\sin (x + 60^\circ) = 1$.
22. Prove $\sin^{-1}\frac{1}{2} + \cos^{-1}\frac{1}{2} = \sin^{-1} 1$.
23. Find tan $(\tan^{-1}\frac{1}{3} + \tan^{-1}\frac{1}{5})$.
24. Solve the equation. Sin A + cosec A = 2.
25. If x and y are acute angles, and x is $> y$
prove $\dfrac{\tan x}{\tan y} > \dfrac{\sin x}{\sin y}$

CHAPTER VI.

THE GONIOMETRICAL RATIOS OF THE DIFFERENCE OF TWO ANGLES.



71. Let BAC contain x angular units, and let CAD contain y angular units, then DAB contains $\overline{x-y}$ units.

As in 61, in AD (the last line we drew) take any point P and draw perpendiculars PN, PQ to AB and AC respectively.

From Q draw QM and QR perpendicular to AB and NP (produced). Then QM = RN and QR = MN.

As before we must show that QPR contains x units.

RPQ $=$ PQM $= 90^\circ -$ MQA $=$ QAM $= x$

$$\text{Sin } \overline{x-y} = \frac{\text{PN}}{\text{AP}} = \frac{\text{NR} - \text{PR}}{\text{AP}} = \frac{\text{MQ}}{\text{AP}} - \frac{\text{PR}}{\text{AP}}$$
$$= \frac{\text{MQ}}{\text{AQ}}\,\frac{\text{AQ}}{\text{AP}} - \frac{\text{PR}}{\text{QP}}\,\frac{\text{QP}}{\text{AP}}$$
$$= \text{Sin } x \cos y - \cos x \sin y.$$

Form. 14.

72. The student is recommended to compare carefully the reasoning of pars. 61, &c. and 71, &c.

73. $$\text{Cos } \overline{x-y} = \frac{\text{AN}}{\text{AP}} = \frac{\text{AM} + \text{MN}}{\text{AP}}$$
$$= \frac{\text{AM}}{\text{AP}} + \frac{\text{QR}}{\text{AP}}$$
$$= \frac{\text{AM}}{\text{AQ}}\,\frac{\text{AQ}}{\text{AP}} + \frac{\text{QR}}{\text{QP}}\,\frac{\text{QP}}{\text{AP}}$$
$$\text{Cos } \overline{x-y} = \cos x \cos y + \sin x \sin y.$$

Form. 15.

74. Here again, as in 63, we must show that $\dfrac{\text{RP}}{\text{AM}} = \dfrac{\text{PQ}}{\text{QA}}$ which can be done precisely in the same manner.

$$\text{Tan } \overline{x-y} = \frac{\text{PN}}{\text{AN}} = \frac{\text{RN} - \text{RP}}{\text{AM} + \text{MN}}$$

Dividing every term of this fraction by AM.

$$= \frac{\frac{\text{QM}}{\text{AM}} - \frac{\text{RP}}{\text{AM}}}{1 + \frac{\text{QR}}{\text{AM}}} = \frac{\frac{\text{QM}}{\text{AM}} - \frac{\text{PQ}}{\text{QA}}}{1 + \frac{\text{QR}}{\text{RP}}\,\frac{\text{PQ}}{\text{QA}}}$$

$$\text{Tan } x - y = \frac{\tan x - \tan y}{1 + \tan x \tan y}$$

Form. 16.

75. The student should notice that the expressions for sin $\overline{x-y}$, &c., only differ from those for sin $\overline{x+y}$, &c., in the signs, and that they can be obtained each from the other, by changing the signs which are expressed, as will be shown when we discuss the meaning of a negative angle, or one generated by the revolution of the movable line in the opposite direction from what we did in par. 27.

76. Before we can prove these relations by the Fig. in par. 66, we must show that BE is = BF, and HF = AC. The former of which is proved in par. 77, and the latter in par 80.

77. In the two triangles, OAE and GBE, since the angles at E are equal and the angles OAE GBE, each contain y units, the remaining angle BGE = AOE, or is a right angle. Hence, BGF is a right angle. But GBF also contains y units, hence the triangles GBE and GBF are equal in all respects, hence BF = BE.

But BF = sin $x - y$ ∴ BE = sin $\overline{x-y}$.

78. Sin $\overline{x-y}$ = BE = BO − OE or BO − OD

$$= \frac{BO}{AB}\,AB - \frac{OD}{AD}\,AD$$

$$= \text{Sin } x \cos y - \sin y \cos x.$$

79. ABC = ABO + OBC

$$= 90^\circ - x + y = 90^\circ - (x-y)$$

Sin $90^\circ - (x-y)$ or cos $(x-y)$ = AC.

Cos $\overline{x-y}$ = AC = AO + OC

$$= \frac{AO}{AB}\,AB + \frac{OC}{CD}\,CD.$$

$$= \text{Cos } x \cos y + \sin y \sin x.$$

80. Since BAF = BHF ∴ HBF = $90^\circ - (x-y)$

But ABC = $90^\circ - (x-y)$

∴ HF = AC.

$$\text{Tan } \overline{x-y} = \frac{BF}{HF} = \frac{BE}{AC}$$

$$= \frac{BO - OD}{AO + OC}$$

$$= \frac{\frac{BO}{AO} - \frac{OD}{AO}}{1 + \frac{OC}{BO}\,\frac{BO}{AO}}$$

$$= \frac{\text{Tan } x - \tan y}{1 + \tan x \tan y.}$$

This formula could have been obtained from the sine and cosine thus:

$$\text{Tan } \overline{x-y} = \frac{\sin \overline{x-y}}{\cos \overline{x-y}} = \frac{BF}{AC} \text{ &c.}$$

81. EXAMINATION AND EXAMPLES.—VI.

1. Prove $\tan x - \tan y = \dfrac{\sin \overline{x-y}}{\cos x \cos y}$
2. Prove $\cot x + \tan y = \dfrac{\cos \overline{x-y}}{\sin x \cos y}$
3. Prove $(\sin \overline{x+y} + \sin \overline{x-y})^2 = 4 \sin^2 x \cos^2 y$.
4. Expand and simplify $(\cos \overline{x+y} + \cos \overline{x-y})^2$
5. In Fig. of par. 66. Draw the line which would represent $\tan \overline{x+y}$ referred to the diameter.
6. If $\tan x = \frac{3}{4}$, and $\tan y = \frac{2}{3}$, find $\tan \overline{x-y}$.
7. If $\tan y = \frac{1}{3}$, and $\tan \overline{x-y} = \frac{1}{7}$, find $\tan x$.
8. If $\sin y = \frac{1}{2}$, and $\sin (x-y) = \dfrac{1}{2\sqrt{2}}\,(\sqrt{3}-1)$

   prove $\sin x = \dfrac{1}{\sqrt{2}}$
9. Prove $\dfrac{1}{\sqrt{2}}(\sin x - \cos x) = \sin (45^\circ - x)$
10. Prove $\dfrac{\tan x + \tan y}{\cot x - \tan y} = \tan x \dfrac{\sin \overline{x+y}}{\cos x + y}$
11. Express $\dfrac{\sin (x-y)}{\cos (x-y)}$ in terms of tangents of x and y.
12. If $\sin \overline{\alpha+\beta} = m \sin \overline{\alpha-\beta}$

    prove $\frac{1}{2}\left(\dfrac{m-1}{m}\right) \cot \beta = \dfrac{\cos \alpha \cos \beta}{\sin \overline{\alpha+\beta}}$
13. With the same conditions as in 12,

    prove $\frac{1}{2}\left(\dfrac{m+1}{m} \tan \beta\right) = \dfrac{\sin \alpha \sin \beta}{\sin \overline{\alpha+\beta}}$
14. Hence from 12 and 13

    prove $\cot \overline{\alpha+\beta} = \frac{1}{2}\left(\dfrac{m-1}{m} \cot \beta - \dfrac{m+1}{m} \tan \beta.\right)$
15. If $\cot^2 \alpha = m$; prove $\cos 2x = \dfrac{m-1}{m+1}$
16. If $\tan^2 x = \tan \overline{\alpha - x} \tan \overline{\alpha + x}$, reduce to sines and cosines, and prove $\dfrac{\sin^2 x}{\cos^2 x} = \dfrac{\sin^2 \alpha - \sin^2 x}{\cos^2 \alpha - \sin^2 x}$
17. Hence from 16, prove $\cos 2x = \dfrac{\cos 2\alpha}{\cos 2x}$
18. Hence from 17, prove $\sin 2x = \sqrt{2} \sin \alpha$.
19. Find cot $(45^\circ + \theta)$.
20. Prove $\dfrac{1 + \tan^2 \theta}{(1 + \tan \theta)^2} = \dfrac{1}{1 + \sin 2\theta}$
21. Find tan $(\tan^{-1} \frac{1}{2} - \tan^{-1} \frac{1}{3})$
22. Prove $(\tan^{-1} \frac{1}{2} + \tan^{-1} \frac{1}{3}) = \tan^{-1} 45^\circ$.
23. Find cos 3 θ in terms of cos θ.
24. In Fig. of par. 66. Draw the line which represents cot $\overline{x-y}$ referred to the diameter.
25. In same figure prove ABH = y.

(To be continued.)

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Animal Physiology.

BY ARTHUR NEWSHOLME, M.D., AND C.S.S. (LOND.)

NUTRITION AND METABOLISM *(continued)*.

The History of Urea.

UREA, the chemical composition of which is represented by the formula CH_4N_2O is a compound which stands on the verge between the organic and inorganic world. It represents the ultimate stage of metabolism at which nitrogenous foods and tissues arrive, and the form in which they are eliminated as waste products. When exposed to the atmosphere in a moist condition it is rapidly decomposed by fermentative influence into carbonate of ammonia, shewing how nearly it has become an inorganic compound. Thus

$$CH_4N_2O + 4H_2O = \left.\begin{matrix}NH_4\\NH_4\end{matrix}\right\}CO_3 + 2H_2O.$$

(urea) + (water) = (carbonate of ammonia) + (water).

It still remains doubtful where urea is formed in the human system, though various surmises having different degrees of probability have been advanced.

Chemical analysis has discovered the presence of urea in the liver, and in the lymph, and chyle, and the blood. It is not normally present in the muscles,

although there is every reason for regarding them as (next perhaps to the liver) the seat of the most important and extensive metabolic functions of the body. But although no urea is present in muscle, it contains various intermediate crystalline nitrogenous bodies, as kreatin, xanthin, and hypoxanthin, there being ·2 to ·4 per cent of kreatin. In the urine kreatin is very small and variable in amount. This combined with the fact that urea is absent from muscle the nervous system (probably) and the spleen and other glandular organs (except the liver), lends weight to the view that kreatin is the antecedent of urea, and that it is the work of the kidneys to convert kreatin ($C_4^{''}H_9N_3O_2$) into urea (CH_4N_2O). This view is only a surmise however; and the fact that the liver, and the blood, and other fluids of the body contain urea tends to shew that urea is formed elsewhere besides in the kidneys.

Another possible source of urea is in the formation of leucin and tyrosin in the pancreatic digestion in the small intestine. It will be remembered that one of the greatest distinctions between gastric and intestinal digestion of proteids, is the formation of these bye-products in the latter process in considerable quantities. Leucin ($C_6H_{13}NO_2$) and Tyrosin ($C_9H_{11}NO_3$) thus formed in the alimentary canal, go straight to the liver (in the portal vein circulation); and this organ, unlike other glandular organs does contain urea normally. It seems very probable therefore that urea is formed in the liver from leucin and tyrosin. That the body can change leucin into urea is shewn by the fact that when leucin is experimentally taken into the alimentary canal in large quantities it appears in the urine as urea; the urea is increased but there is no leucin in the urine. That the liver is the seat of the change of leucin into urea is rendered still more probable by what occurs in the disease known as Acute Atrophy of the Liver. In this disease the liver cells become disorganised and broken down, and concomitantly urea diminishes or disappears from the urine, and is replaced by leucin and tyrosin.

History of Uric Acid.

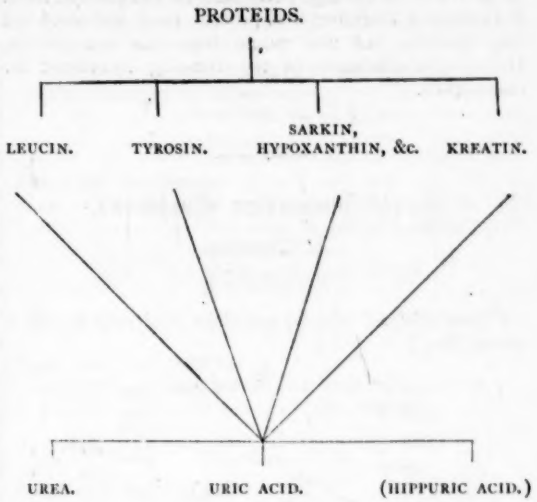
Uric acid ($C_5H_4N_4O_3$) is present normally in the urine, but in very much smaller quantity than urea. It also occurs like urea in the blood and liver; and in addition in the spleen. It is constantly present in the spleen even of animals such as herbivora, whose urine has none. The spleen seems to be the organ in which uric acid is formed. In fevers and ague, swelling of the spleen is always associated with an increase of uric acid in urine.

By oxidation the molecule of uric acid can be split up into two of urea and one of mesoxalic acid. Thus

$$\underset{\text{uric acid}}{C_5H_4N_4O_3} + \underset{\text{chlorine}}{Cl_2} + \underset{\text{water}}{4H_2O} = \underset{\text{urea}}{2CN_2H_4O} + \underset{\text{mesoxalic acid}}{C_3H_2O_5} + \underset{\text{hydrochloric acid}}{2HCl}$$

It is evident therefore that uric acid represents a less completely oxidised form of proteid metabolism than urea. One cannot regard a deficient supply of oxygen as determining the formation of uric acid instead of urea; for in the rapidly breathing birds, uric acid takes the place of urea entirely (in reptiles the same). Uric acid is much less soluble in water than urea, and is more adapted to the solid excreta of birds and reptiles than urea.

The metabolic changes previously described may be shewn diagramatically as follows:—



Proteid Metabolism

When a diet of lean meat is given to a dog which had been previously starved for some days, contrary to what might be expected no storing up of the ingested food occurs, but the larger portion at once passes off as urea. Thus a nitrogenous diet immediately increases the amount of urea in urine, owing to the greatly increased nitrogenous metabolism. It is difficult to maintain an equilibrium between the food and the egesta, on a purely nitrogenous diet, the tendency being for wasting to occur. Hence a liberal meat diet does not of itself tend to an increase of the body weight or strength. A familiar example of this is the Banting treatment for corpulence, which consists in a restriction of the diet to lean meat and water, with very small quantities of bread and no other amyloid food. The ingestion of nitrogenous food increases the oxidation not only of nitrogenous materials, but also of non-nitrogenous, and so a general wasting is produced.

Effect of Fatty Food on Proteid Metabolism

We cannot study the effects of fatty food alone, as it is not sufficient alone to maintain life. Its effects must therefore be studied when taken along with proteid food. When a small quantity of fat is taken with proteid food, the whole of it may reappear in the excreta. If in larger quantities, a portion of it is retained in the body as fat. It is evident therefore that an increase of fatty food does not increase the oxidation of fats. In fact it is found to have just the opposite effect, tending to diminish fatty metabolism. And the fat stored up in the body has just the same effect as that taken in food. It lessens tissue-waste and secondarily oxidation. This is the reason why corpulent persons frequently continue to become stouter, even though they are very moderate eaters. Each deposit of fat increases the tendency to further deposit.

Not only does fatty food diminish non-nitrogenous oxidation, but also nitrogenous oxidation. If fats are added to the food, nitrogenous equilibrium is established with a smaller expenditure of proteid food. On the other hand with a fixed quantity of fatty food, an

increase of the proteid food accompanying it, led to an increased oxidation of carbon and not to a storing up of the extra carbon contained in the proteid food. It is evident therefore that proteid food increases not only proteid, but also non-nitrogenous metabolism. Hence the efficiency of the Banting treatment for corpulence.

(To be continued.)

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Recent Inspection Questions.

Arithmetic.

STANDARD I.

(Sums dictated slowly, and then read over quickly a second time.)

A.

(1) 38, 308, 380, 97, 456 — 1,279. Ans.

(2) 401, 290 — 111. Ans.

(3) 811, 29 — 782. Ans.

B.

(1) 75, 507, 70, 856 — 1,508. Ans.

(2) 600, 291 — 309. Ans.

(3) 459, 69 — 390. Ans.

(Words dictated once.) Noise, bright, voice, gloves, milk, child, people, Saturday, streets, pleasant.

STANDARD II.

(Dictated as in Standard I.)

A.

1. From 721 take 172. 549. Ans.
2. Multiply 45,907 by 906. 41,591,742. Ans.
3. Divide 80,111 by 9. $8901\frac{2}{9}$. Ans.

B.

1. From 39,008 take 5,010. 33,998. Ans.
2. Multiply 8,765 by 670. 5,872,550. Ans.
3. Divide 94,681 by 12. $7,890\frac{1}{12}$. Ans.

STANDARD III.

(The whole of the questions were in words.)

1. Add together £19 17s. $9\frac{3}{4}$d., £14 8s. 8d., £38 14s. $6\frac{1}{2}$d., and £98 17s. 7d.
£171 18s. $7\frac{1}{4}$d. Ans.

2. How many times will 98 go into 58,679?
$598\frac{75}{98}$. Ans.

3. Take £79 18s. $11\frac{3}{4}$ from £268 19s. $0\frac{1}{4}$d.
£189 0s. $0\frac{1}{2}$d. Ans.

4. A boy went to the Savings' bank and put in 2s. 6d., 5s. 6d., 7s. 2d., and 4s. 3d. at different times. He afterwards drew out half a sovereign and a crown. What did he leave in the bank.
(2s. 6d. + 5s. 6d. + 7s. 2d. + 4s. 3d.) − (10s. + 5s.) =
4s. 5d. Ans.

STANDARD IV.

A.

1. Find the difference between £368 11s. $4\frac{1}{2}$d. and £29 16s. $9\frac{1}{4}$d., and multiply the answer by 68.
£338 14s. $7\frac{1}{4} \times 68$ = £23,033 13s. 1d. Ans.

2. £256,040 16s. $3\frac{1}{2}$d. ÷ 39.
£6,565 2s. $11\frac{3}{4}\ \frac{5}{39}$d. Ans.

3. Reduce 59 m. 0 fur. 18 pls. 2 yds. to feet.
311,823 feet. Ans.

4. At a cricket match, £15 10s. was taken at the gate in twopences, and £23 19s. in sixpences; how many people were admitted into the field?
£15 10s. = 310s. = 1860 twopences.
£23 19s. = 479s. = 958 sixpences.
Total No. of people = 2,818. Ans.

B.

1. Reduce 29,467 lbs. to tons.
13 tons 3 cwt. 0 qr. 11 lbs. Ans.

2. £6,437 13s. $7\frac{1}{4} \times 76$. £489,263 13s. 11d. Ans.

3. Divide £5,079 13s. $2\frac{1}{4}$d by 309.
£16 8s. $9\frac{1}{4}\ \frac{144}{309}$. Ans.

4. A hall is 255 sq. yds. 6 sq. ft. in area, how many seats, each 5 sq. ft. 45 sq. ins. will it hold.
255 sq. yds. 6 sq. ft. ÷ 5 sq. ft. 45 sq. in. =
331,344 sq. ins. ÷ 765 sq. ins. = $433\frac{99}{765}$. Ans.

STANDARD V.

1. If 5 cwt. of sugar can be bought for £5 16s. 8d., what will be the cost of $3\frac{1}{2}$ doz. lbs.
560 lbs. : 42 lbs. :: £5 16s. 8d. : 8s. 9d. Ans.

2. Find by practice the cost of 45 sq. yds. 6 sq. ft. 36 sq. in., at 12s. per sq. yd. £27 8s. 4d. Ans.

3. From $(\frac{3}{5} + \frac{4}{9})$ take $(\frac{2}{3} - \frac{3}{7})$.
$(\frac{3}{5} + \frac{4}{9}) - (\frac{2}{3} - \frac{3}{7}) = \frac{47}{45} - \frac{5}{21} = \frac{254}{315}$. Ans.

4. Make a bill for—$25\frac{1}{2}$ yds. @ 1s. 2d. per. yard, 19 yds. @ 3s. 10d. per yd., 15 sq. yds. 4 sq. ft. @ 1s. 6d. per sq. yd. and $8\frac{1}{2}$ doz. carpet rings @ $\frac{1}{2}$d. each.
£1 9s. 9d. + £3 12s. 10d. + £1 3s. 2d. + 4s. 3d.
= £6 10s. 0d. Ans.

STANDARD VI.

1. Find the cost of laying 675 miles of piping at 3s. 6d. per yd.
675 mls. or 1,188,000 yds. @ 3s. 6d.
= £207,900. Ans.

2 If $\frac{3}{8}$ cwt. of soap can be bought for 8s. 9d. what fraction of a cwt. could be bought for 11s. 8d.?
8s. 9d. : 11s. 8d. :: $\frac{3}{8}$: $\frac{1}{\square}$. Ans.

3. If I invest £50 for $4\frac{1}{2}$ years at three per cent. what amount of interest shall I obtain.
$(50 \times 4\frac{1}{2} \times 3) \div 100$ = £6 15s. Ans.

4. A joiner got $\frac{4}{7}$ of the cost of a house; the bricklayer got $\frac{1}{3}$; the rest which was £60 went to the plasterer. What was the cost of the house?

$$1 - (\tfrac{4}{7} + \tfrac{1}{3}) = \tfrac{2}{21} - \left(\frac{12 + 7}{21}\right) = \tfrac{2}{21}.$$

$\frac{2}{21} : 1 :: £60 : £630$. Ans.

STANDARD VII.

1. In a cricket match the highest score was ·35 of the total score; the next was ·25, and the rest yielded 120, what were the highest, the second, and the total scores?

$1 - (\cdot35 + \cdot25) = \cdot4$
$\cdot4 : 1 :: 120 : \underline{300}$ Total score.
$1 : \cdot35 :: 300 : \underline{105}$ Highest score.
$1 : \cdot25 :: 300 : \underline{75}$ Second score.

2. A man owned $\frac{2}{5}$ of an estate; he sold $\frac{3}{5}$ of his share for £4,500: what was the estate worth at the same rate?

$\frac{3}{5}$ of $\frac{2}{5} : 1 :: £4{,}500 : \underline{£18{,}750}$. Ans.

3. If six persons can live for a fortnight on £52, what would it cost at the same rate of living 7 persons to live for half the time?

persons 6 : 7 :: £52 : £30 6s. 8d. Ans.
weeks 2 : 1

4. In a school there were 70 boys, and 75 girls; there was an increase of 10 per cent. in the number of boys, and 8 per cent. in the number of girls: How many were there in the school after the increase?

$70 + \frac{10}{100}$ of $70 = 77$ boys.
$75 + \frac{8}{100}$ of $75 = 81$ girls.
Total $= \underline{158}$. Ans.

Dictation and Composition.

STANDARD II.

'Oh, but I must go,' said Paul; 'I have the sheep to mind. Look over at the opposite hill and see how faithfully Rollo is guarding them till I return, and how he keeps looking this way to see when I am coming.'

STANDARD III.

Richard did all that a skilled soldier could do to win the day. Where the fight was thickest he was seen in the midst urging those who remained faithful to battle till the last. Then he caught sight of Henry among the knights and made up his mind by personal valour to turn the fortune of the day.

STANDARDS IV. AND V.

An exile from the Saxon land, coldly treated by the Saxon people, and entirely disregarded too by Emma, his mother, he was warmly attached to the Norman companions of his early days. They surrounded his court and fed and feasted on the wealth of the English people, whilst many of them were promoted to the posts of highest honour in the land. A Norman was made Archbishop of Canterbury.

STANDARD VI.

Write an Essay on 'A Ship.'

STANDARD VII.

Write an Essay on 'The Sea.'

Grammar and Analysis.

STANDARD III.

(*a*) Pick out adjectives and pronouns, and (*b*) verbs and abverbs in the Dictation exercise.

STANDARD IV.

Parse and Analyse:—
(*a*) 'Why do they look so well?'
(*b*) 'They gored her sides like the horns of an angry bull.'
(*c*) 'There came a burst of thunder sound.'
(*d*) 'To-night no moon we see.'

STANDARD V.

Parse and Analyse:—
(*a*) 'The last of all the bards was he.'
(*b*) 'Below the bank grew some tall rushes.'
(*c*) 'The bigots of the iron time
Had called his harmless art a crime.'

STANDARD VI.

Parse and Analyse:—
'You all did see that on the Lupercal
I thrice presented him a kingly crown.'

STANDARD VII.

Parse and Analyse:—
'I believe the story he told me.'

—o—

The 'Practical Teacher' Prize Competition for Pupil Teachers.

JUDGE—C. J. DAWSON, ESQ., B.A.,

Ex-President of the National Union of Elementary Teachers.

As promised in our last issue we here print selected Answers to the Prize Examination Questions; and in doing so we wish to point out that they are not offered as perfect answers but as selected from the best of the answers actually sent by the competitors. We are not, therefore, responsible for any inaccuracy they may contain, or for any imperfections of style. On the whole, however, we consider the work printed to be very creditable to the Pupil Teachers, and a careful examination of it will be likely to afford useful suggestions to others who are preparing for the Government Examinations.

Some difficulty arises in estimating the value of parsing and other questions in Grammar from the great variety of methods of treatment taught by different grammarians. In a future number we hope to give some special help on this subject.

We have not given any of the worked answers to the Questions in Arithmetic for Second Year Female Pupil Teachers, because, though they were for the most part correct, the working was needlessly lengthy and roundabout. We append our own working of these questions as a sample of the application of more concise methods. We also give the solution of a question in Algebra which none of the competitors managed to do correctly.

The name and address of 'Mercara,' who won the prize offered to Male Pupil Teachers of the First Year, whose address was lost, is:—Frank Wright, Rawlinson Street Boys' Board School, Barrow-in-Furness.

ANSWERS TO EXAMINATION PAPERS.

FIRST YEAR.

Arithmetic.

MALES.

1. Find the shortest length of rope which can be exactly measured by each of four measures, 3 ft., 3½ ft., 5 ft., and 4 ft. 7 in. long respectively.

3 ft. = 36 in. ; 3½ ft. = 42 in. ; 5 ft. = 60 in. ; 4 ft. 7 in. = 55 in.

L.C.M. of 36, 42, 60, 55.

2) 36, 42, 60, 55
2) 18, 21, 30, 55
3) 9, 21, 15, 55
3) 3, 7, 5, 55
5) . 7, 5, 55
7 11

∴ L.C.M. = (2×2×3×3×5×7×11) in. = 13860 in. = 1155 ft. long. Ans. [*Mercara*]

2. From $\frac{4}{9}$ of a ton subtract $2\frac{3}{4}$ cwts. and express the remainder as a decimal of a ton.

$\frac{4}{9}$ ton = $\frac{4}{9} \times \frac{20}{1} = \frac{80}{9}$ = $14\frac{2}{9}$ cwts.

$14\frac{2}{9}$c.—$2\frac{3}{4}$c. = $\left(\frac{100}{7} - \frac{11}{4}\right)$ c. = $\frac{400-77}{28}$ c. = $\frac{323}{28}$ c.

Therefore reqd. dec. = $\frac{\frac{323}{28} \text{ cwts.}}{1 \text{ ton}}$ = $\frac{323}{28} \div \frac{20}{1}$ =

$\frac{323}{28} \times \frac{1}{20} = \frac{323}{560}$ = ·5767857142. Ans. [*Mercara*]

3. Two-thirds of an estate is left to A, and two-sevenths to B, the remainder falling to C is worth £506. What is the value of A's share and of C's?

A + B = $\frac{2}{3} + \frac{2}{7} = \frac{14+6}{21} = \frac{20}{21}$

∴ C = $\frac{1}{21}$ but this equals £506

∴ the whole estate = £506 × 21
= £10626

Then A's share = £10626 × $\frac{2}{3}$
= £7084

£7084 A's share
£ 506 C's share } Ans. [*Nullum Nomen*]

4. Divide ·079 by 7·39 and express the answer as a decimal.

·79 ÷ 7·39
= $\frac{79}{1000} \div \frac{739}{100}$
= $\frac{79}{1000} \div \frac{739}{100}$
= $\frac{79}{10} \div \frac{37}{5}$
= $\frac{79}{10} \times \frac{5}{37}$
= $\frac{79}{74}$
= ·0108 Ans. [*Van*]

FEMALES.

1. Make a bill for the following, and show how it should be receipted when paid :—

London, March 5, 1886.

Mr. Smith,
Bought of John Brown.

	£	s.	d.
59 yards of silk @ 4s. 7½d. per yd. ...	13	10	5
27 yards of calico @ 6½ per yd. ...	0	14	7½
83 yards of ribbon @ 1s. 3½d. per yd.	5	3	9
15¾ doz. buttons @ 4s. 3d. per doz. ...	3	6	11¼
4½ yards of velvet @ 12s. 9d. per yd.	2	17	4½
	£25	13	1¼

Paid

March 8th, 1886.
JOHN BROWN.

[*Snowdrop*]

2. Find, by practice, the value of 3115 ounces of plate at 13s. 9½d. per oz.

	£	s.	d.	
	3115	0	0	
10s. = ½ of £1	1557	10	0	value of 10s. 0d.
3s. 4d. = ⅓ of £1	519	3	4	value of 3s. 4d.
5d. = 1/12 of 3s. 4d.	64	17	11	value of 5d.
½ = 1/10 of 5d.	6	9	9½	value of ½d.
	£2148	1	0½	value of 13s. 9½d. Ans.

[*Snowdrop*]

3. What would be the rent of a farm containing 53 acres 3 rds. 10 per. at £3 7s. 8d. per acre.

	£	s.	d.	
	3	7	8 × 53	
			10	
	33	16	8	
			5	
	169	3	4	
	10	3	0	
	179	6	4	value of 53 acres
2 roods = ½ of an acre	1	13	10	,, 2 roods
1 rood = ½ of 2 roods		16	11	,, 1 rood
10 perches = ¼ of 1 rood		4	2¾	,, 10 perches
	£182	1	3¾	value of 53a. 3r. 10p. Ans.

[*Snowdrop*]

4. What numbers less than 1000 can be exactly divided by each of the integral numbers less than 8?

2) 1 2 3 4 5 6 7
2 5 3 7
2 × 2 × 5 × 3 × 7 = 420
420 × 2 = 840 } Ans.

[*Snowdrop*]

Grammar.

1. Parse and analyse :—

'Thrice is he armed that hath his quarrel just.'

Thrice—Adv. of degree mod. the verb armed.
is—Part of verb to be.
he—Pers. pro., 3rd pers., sing. no., masc. gender, nom. to verb is armed.
armed—Past part. of verb to arm.
is armed—Verb, intrans., 3rd pers., sing. no., agreeing with nom. he, pres. tense, indic. mood, passive voice.
that = who—Rel. pro., 3rd pers., sing. no., masc. gender, agreeing with its antecedent he, nom. to finite verb hath.
hath—Finite verb, trans., 3rd pers., sing. no., agreeing with nom. that, pres. tense, indic. mood.
his—Pronominal adj., 3rd pers., sing. no., masc. gender, qual. the noun quarrel.
quarrel—Common noun, sing. no., neut. gender, obj. case after verb hath.
just—Adj. qual. quarrel, pos. degree.

Sent. (*a*) *He is thrice armed*—Princ. sent.

He	Subj.
is armed	Pred.
thrice	Ext. pred. (deg.)

Sent. (*b*) *That (who) hath his quarrel just*—Sub adj. S. qual. he in (*a*)

That (who)	Subj.
hath	Pred.
his and just	Enlargements of obj.
quarrel	Obj. dir.

[*Nullum Nomen*]

2. Distinguish between the various uses of the form made by adding *ing* to the verb.

(1) Forms the word into an imperfect participle, as
'The horse was running.'
(2) Forms the word into an adjective, as
'The bellowing bull.'
(3) Forms the word into a gerund or verbal noun, as
'During the reading of the will.'
(4) Sometimes the word ending in *ing* is used in place of an infinitive, as
'The horse began running down the lane.'

[*Mercara*]

3. Give as complete a classification of adjectives as you can, and explain it.

Nouns are not qualified or affected in the same manner by all adjectives, and we classify the adjectives according to the manner in which they qualify the nouns to which they are joined. The following are the chief classes into which the adjectives are divided.

Adjectives of Quality (Latin 'Qualis' 'What Kind') these adjectives are so called because they answer to the question, what kind; as a *good* boy, &c., here the adjective good tells the kind of boy. This class also includes the *participial adjectives*, as a *bellowing* bull; and also the *proper adjectives* as a *Swiss* peasant.

Adjectives of Quantity (Latin 'Quantus,' an amount); these adjectives are so called because they tell the quantity or amount of the noun, and they answer to the questions, How much? How many? as *Many* trees, here many tells the quantity (indef.) of trees. This class includes the *Numeral Adjectives* (both definite and indefinite), as *two* books, and also the *Distributive Adjectives.*

Demonstrative or *Distinguishing Adjectives* (Latin 'Demonstro' 'I point out'); these adjectives are so called because they point out or distinguish one noun from any other, and they answer to the questions, What? Which? as *this* book. This class includes the *Pronominal Adjectives*, as *his* book. [*Mercara*]

Geography.

2. Mention the different mining industries of Great Britain, the districts in which each of them is carried on, and give a full account of one of the most important.

Coal and Iron—found in Durham, Northumberland, Lancashire, Staffordshire, Leicester, Warwick, Coalbrookdale, Dean Forest, Flint, Anglesey, South Wales, Lanark, Dumfries, Glasgow, Ayr, Stirling, and Carron.
Lead—found in Derbyshire, Cumberland, Northumberland, and Lowther Hills.
Copper—found in Cornwall, Devon, Anglesey, and Loch Tay.
Tin—found in Cornwall and Devon.
Salt—Cheshire, and at Droitwich.
Slate—found in Cumberland, Penrhyn, Argyleshire.
Building Stone—found in Durham, Yorkshire, Portland.
Granite—found in Devon, Cornwall, Aberdeen, and Peterhead.
Plumbago—found in Keswick.
Alum—found in Whitby.
Marble—found in neighbourhood of Torbay, and in Sutherlandshire.

Coal mining is one of the most important of British mining industries. It is extensively carried on at the above-mentioned coal-fields. Coal is found at various depths; in some places it is found quite near the surface, and the coal-mine then has the appearance of a quarry. One is to be seen at Sedgeley, in South Staffordshire. In most cases, however, coal is found at a greater depth, in some places as far down as 600 yards from the surface. A shaft is sunk, by means of which the miners descend in a cage, suspended to a chain, wound by an engine. Waggons of coal are brought from all parts of the mine to the bottom of the shaft, and are then placed in a cage, and by means of the engine are drawn to the top of the mine. The coal is then weighed, and tipped into trucks or railway waggons to be sent to various parts. [*Espérance*]

3. Compare the geographical features of Wales with those of E. Anglia, the eastern counties of England?

The Welsh counties are very mountainous, and the rivers are very rapid. The soil is not very fertile, but minerals are very abundant, the climate is mild but rainy on the coast. The coast is very much broken by the violent action of the Atlantic, and the shores are very steep and rugged.

The East Anglian counties are very flat, forming part of the Eastern plain of England. The only mountains of importance are the East Anglian heights, and the rivers are not very rapid. The soil is very fertile, large quantities of corn being grown, there is, however, a total absence of minerals. The climate is much colder than that of the Welsh counties. The shores are low and sandy. [*Mercara*]

4. Write an account of the commerce between Great Britain and British North America.

British North America having on the whole a cold climate the pine grows extensively, and timber is an important item of export. In the south the climate is more genial, and wheat grows in abundance, and with flour is also exported to Great Britain. Cattle, and the flesh of cattle in the form of tinned meats, are also exported, together with pot and pearl ash. Fish, salmon from the lakes, and cod (from which is made and exported cod liver oil) from off the coast of Newfoundland is also exported, and gold from British Columbia. In return for these articles the people of Great Britain send to British North America manufactured goods of cotton, wool, and linen, hardware, tea, and wines.

[*Snowdrop*]

History.

1. What were the most striking incidents in the Roman Conquest of Britain, and what were the more important of its permanent results?

Britain was invaded by the Romans first in 55 B.C. Their leader Julius Cæsar landed with his troops near Deal. In the battle which followed the Britons were defeated. Julius Cæsar stayed 17 days on the island and then returned to Gaul (France). He returned to Britain the following year 54 B.C. He was again victorious. The Britons under Cassivellaunus were gradually defeated, Cæsar exacted hostages, imposed a tribute, and left Britain. For a hundred years Britain was left unmolested by the Romans. In 43 A.D. Claudius Cæsar determined on its reinvasion and an army under the command of Aulus Plautius and Vespasian was sent to Britain. Suetonius Paulinus, 59-61, a politic general, subdued Mona (Anglesea) the seat of the Druids. Julius Agricola, 78-85, did more to complete the conquest of Britain than any Roman General. He not only subdued the Britons but taught them the useful arts, he built walls to protect the southern part of the island, he advanced northward into Caledonia (Scotland) and circumnavigated the island. The Romans left Britain about 420 to guard their own country from enemies.

Some of the permanent results of the Roman Conquest of Britain were the introduction of Christianity, the civilization of the natives, the erection of strong forts and cities, the making of good roads, and the introduction of Latin words into our language. [*Snowdrop*]

2. Narrate briefly the events that led to the establishment of the several Saxon kingdoms in South Britain, and their ultimate union into one.

When the Romans left Britain, the Britons were left in a perfectly defenceless state, and they fell an easy prey to the warlike races of the north. Being unable to get the assistance of the Romans, they, following the advice of Vortigern, one of the most powerful of their chiefs, asked over the help of a race called the Saxons, who inhabited the North of Germany, and Denmark. The Saxons then came to the help of the Britons, and soon succeeded in driving out the Picts and Scots. The Britons then granted them the Isle of Thanet in return for their services, but the Saxons were not content with this, and they then seized the whole of Kent; after this many other bands of Saxons landed in England, and formed kingdoms. The following were the most important of those in South Britain:—

Kent, founded by Hengest in 457.
Sussex, founded by Ella in 490.
Wessex, founded by Cerdic in 510.
Essex, founded by Ercenwin in 527.

These states, as well as several minor ones which had been formed, were continually struggling amongst themselves, until at last, in 800, Egbert of Wessex became king of South Britain. [*Mercara*]

3. Write an account of Alfred or of Edward the Confessor.

When Alfred came to the throne, on the death of his brother Ethelred, in 871, the country was almost all in possession of the Danes. Alfred was defeated in several battles by the Danish leader Guthrum, and being unable to cope with them, he was forced to flee into hiding. He took refuge in the Isle of Athelney (Somersetshire), where he spent a long time in gathering an army and arranging his plans. In 878 he suddenly issued from his retreat, and fell upon the Danes at Ethandune in Wiltshire, and he completely defeated them. This battle was followed by a treaty called the peace of Wedmore, by this treaty Guthrum agreed to retire into the north of the country. A few years afterwards, a Danish army under a leader called Hastings, landed in England, but after being defeated in several battles he retired from the country. The remainder of Alfred's reign was peaceful; he devoted his time to the welfare of the nation. He built castles, and schools, and equipped a fleet of ships to guard the coasts. He translated several Latin Books into English, for the benefit of his subjects. His death took place in 901.

[*Mercara*]

Music.

1. Name all the signs used in the following staff:

is the sign of the Treble Clef.

,, ,, Common Time.

 ,, ,, a Minim.

,, ,, Crotchet.

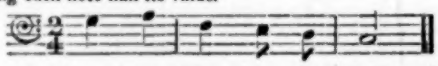
,, ,, Semibreve.

,, ,, Ledger Line.

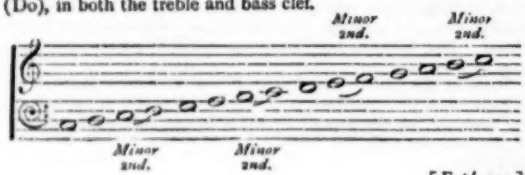
,, ,, Bar.

,, ,, Double Bar.

2. Write the above phrase an octave lower on the bass staff, giving each note half its value.



3. Give the positions of the minor seconds in the scale of C (Do), in both the treble and bass clef.



[*Espérance*]

SECOND YEAR.

Euclid.

MALES.

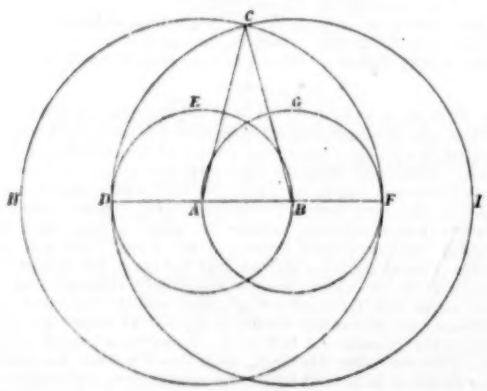
1. Book I. Proposition 7.

2. Book I. Proposition 20.

3. Describe an isosceles triangle with each of the equal sides double of the base.

Let AB be the base, it is required to describe an isosceles triangle on AB.

From cent. A at dis. AB describe circle BED
From cent. B at dis. BA describe circle AGF } (Post. 1.)



Produce AB both ways to points D and F (Post 2.)
From centre A at dis. AF describe circle FCH.
From centre B at dis. BD describe circle DIC.
From Point C where circles cut one another draw CA, CB to points A and B.

ABC shall be the triangle required.

Because A is centre of circle BED, AB = AD (Def. 15.)
∴ DB is double AB. Because B is cent. of circ. AGF, AB = BF. ∴ AF is double AB.

Because A is centre of circle FCH, AC = AF.
But AF is double AB. ∴ AC is double AB.

Because B is cent. of circle DIC, BD = BC (Def. 15.)
But BD is double AB. ∴ BC is double AB.

Wherefore on a given base AB an isosceles triangle CAB has been described having its = sides CA, CB each double of the base AB. Q.E.F. [*Jimmy*]

Grammar.

'The *very law which* moulds a tear,
And *bids it trickle* from its source—
That *law preserves* the *earth* a *sphere*,
And *guides* the planets in *their* course.'

1. (*a*) Paraphrase the above; (*b*) analyse it; (*c*) parse words in italics.

(*a*) Small and great things are alike affected by the law of gravitation. 'Tis that law that forms the little tear-drop, and causes it to roll down the cheek, and it is the same law that keeps the earth in a globular form, and controls the movements of the whole solar system.

(*b*)

Sentence.	Kind.	Con. word.	Subject.	Pred.	Object.	Ex. of Pred.
(*a*) The very law, that law preserves the earth a sphere	Prin. Sent.		The very law that law	preserves	the earth a sphere	
(*b*) Which moulds a tear	Adj. Sen. qual. law in (*a*)		which	moulds	a tear	
(*c*) And bids it trickle from its source	Adj. Sen. co-or. to (*b*) qual. law in (*a*)	And	which	bids	it (Direct) trickle from its source (Ind. Obj.)	
(*d*) And guides the planets in their course	Prin. Sen. co-or. to (*a*)	And	(that law)	guides	the planets (Direct)	in their course

(*c*)

very—adj. of qual. qual. 'law.'

law—com. noun, neu. gen., 3rd per., sing. num., nom. case 'preserves.'

which—rel. pro., neu. gen., 3rd per., sing. num., agr. with ante 'law,' nom. case 'moulds.'

bids—irreg. tran. verb, act. voice, ind. mood, pres. tense, 3rd per., sing., agr. nom. (which.)

it—pers. pro., neu. gen., 3rd per., sing. num., obj. case, gov. by 'bids.'

trickle—reg. int. verb., inf. mood, gov. by 'bids'

law—com. noun, neu. gen., 3rd per., sing. num., nom. case to 'preserves' in app. with 1st law.

preserves—reg. trans. verb, act. voice, ind. mood, pres. tense, 3rd per., sing., ag. with 'law.'

earth—com. noun, neu. gen., 3rd per., sing. num., obj. case, gov. by 'preserves.'

sphere—com. noun, neu. gen., 3rd per., sing. num., obj. case, gov. by 'preserves' in app. 'earth.'

guides—reg. trans. verb, act. voice, ind. mood, pres. tense, 3rd per., sing. num., 'law.'

their—poss. adj. pro., neu. gen., 3rd, sing., qual. 'course.'

[*Jimmy*]

2. Give the meaning of the Latin prefixes, ad, con, ex, in, and sub and illustrate by examples how each of them may take different forms.

Prefix.	Meaning.	Modifications.	Examples.
ad	to	ac, af, ag, al, an, ap, as, ar, at	account, affect, agglutinate, allay, annex, approach, ascertain, arrive, attempt, adhere
con	with, together with	co, col, con, com	co-operate, collect, comply, connect
ex	out of, out	e, ef	exodus, efface, erase
in	in, not	ig, im, il, ir	ignominious, improper, illiterate, irreverent
sub	under	suc, suf, sug	succour, suffer, suggest

[*Jimmy*]

3. What prefixes are used in the formation of adjectives of Latin origin. Give examples?

Affix.	Examples.	Affix.	Examples.
al	natural, artificial	an	german, human
ar	polar, globular	id	fervid, acid
ive	productive, attentive	ous	dangerous, riotous
ory	cursory, amatory	ine	masculine, feminine
ose	verbose		

[*Jimmy*]

Geography.

2. What are our chief imports from the peninsular countries of Europe?

Scandinavia—timber, fish, furs, iron, copper.

Denmark—corn (wheat, barley, rye, oats), oxen, horses, butter, rape-seed, salt meats.

Spain—wines, brandies, fresh and dried fruits (nuts, oranges, &c.), silk, wool, lead, quicksilver, cork, esparto-grass, olive-oil, skins.

Portugal—oranges, lemons, figs, wines, wool, salt.

Italy—olive-oil, southern fruits, almonds, wines, silk (raw and manufactured), kid and lamb-skins, marble, sulphur, alum, straw hats and plait, liquorice, essences, and perfumery.

Various countries of Balkan Peninsula—cotton, tobacco, wines, opium, carpets, morocco leather, currants and other fruits. [*Jimmy*]

4. Explain the meaning of Latitude and Longitude, and show in what way correct knowledge about them is practically useful.

Latitude is distance North or South of the Equator (a line drawn round the centre of the earth where it is thickest).

Longitude is distance E. or W. of any fixed Meridian (a line drawn from one Pole to the other). The line we calculate from is the one which passes through Greenwich. Other nations choose one for themselves.

If we possess a correct knowledge of these lines, we can find any point on the earth's surface. Especially is it useful to sailors when out on the wide ocean with no landmarks to guide them. This knowledge and the mariner's compass is their only safety from the perils of the sea.

The scene of a wreck may be described in the newspapers as in Lat. 45° N. and W. Long. 6°.

Those who have no knowledge of Lat. and Long. will have no idea where this place is, while others, without the aid of a map, know that it is in the Bay of Biscay, W. of Bordeaux.

Again, the sun appears to move round the earth in 24 hours, and, as the globe is divided into 360°, every place 15° E. of Greenwich sees the sun an hour earlier than we do, and, of course, in the opposite direction quite the reverse.

Calcutta is in Long. 90° East, therefore the people get daylight six hours before we do, and as St Petersburgh is in Long. 30° E., daylight appears four hours after sunrise in Calcutta. New York (Lat. 75° W.). People there are at breakfast when it is 12.30 p.m. with us. [*Jimmy*]

Arithmetic.

Find the simple interest on £535 16s. 8d. @ 2½ % per annum for 4½ years?

If £100 gets £2 10s. in one year

∴ £535 16s. 8d. in 4½ years gets

As £100 : £535⅔ :: £2 10s.

6 6

600 3215

1200 643

40

1yr : 4½ :

2 2

2 9

80 1929

2¼

3858

964·10

80)4822·10

£60 5s. 7½d. Ans. [*Jimmy*]

2. If a man has £10,500 invested at 4½ % per annum, what will the income tax on his dividend amount to at 8d. in the pound?

£100 gets £4½.

∴ £10,500 gets $\frac{£4\frac{1}{2} \times 10500}{100}$ = £472 10s. Dividend.

Income tax = 472½ × 8d. = 3780d. or £15 15s. Ans.

3. At what rate per cent. simple interest would £1350 amount to £1621 13s. 9d. in 5¾ years?

Interest gained = (1621 13s. 9d. − £1350) = £271 13s. 9d.

If £1350 in 5¾ years gains £271 13s. 9d. then £100 in one year will gain:

As £1350 : £100 :: £271 13s. 9d.

5¾ yrs. : 1 yr. ::

$$= \frac{£271\ 13s.\ 9d. \times 100 \times 4}{1350 \times 5\frac{3}{4} \times 4} = \frac{£1086\ 15s.}{297} = 3\frac{2}{3}\ \%\ \text{Ans.}$$

[*Jimmy*]

4. A person selling a house for £540 gained 4 % on what he gave for it. The person from whom he bought it lost 4 % on what it had cost him. What was the cost to the latter?

1st. What was bought for £100 was sold for £104.

As £104 : £540 :: £100 : 1st prime cost.

$$x = \frac{100 \times 540}{104} = \frac{6750}{13} = £519\ 4s.\ 7\tfrac{9}{13}d.$$

2nd. What was bought for £96 cost £100.

As £96 : £100 :: £519 4s. 7⁹/₁₃d. : real cost

$$x = \frac{100 \times £519\ 4s.\ 7\frac{9}{13}}{96} = £540\ 17s.\ 3\tfrac{8}{13}d.\ \text{Ans.}$$

[*Philomel*]

History.

1. Write some account of the most important events in the reign of John.

The three important events in John's reign are—

1st. His war with France and loss of Normandy. John was an usurper. His elder brother Geoffrey had left a son Arthur, who ought to have succeeded his uncle Richard I. The French King Philip II., glad of any excuse to go to war with England, maintained Arthur's rights, and openly denounced John as an usurper. A war ensued. At a skirmish before the castle of Mirabeau, in Normandy, Arthur was taken prisoner, conveyed to Rouen Castle, and there murdered, 1202. Whether the deed was done by hired assassins or by the King himself is still a matter of dispute. He was now accused of the murder of Arthur, and called before Philip to give an account of himself. No John appeared, and Normandy was declared confiscated. The English King seemed quite indifferent, and allowed these matters to go on smoothly until Normandy was secured by the French. All the once vast possessions in France had dwindled away, except Poitou and Aquitaine, the dowry of his Royal mother Eleanor (1204).

2nd. Disputes with the Pope. It happened about this time that the See of Canterbury became vacant. The monks chose a Primate, and the King appointed John de Grey, Bishop of Norwich. Both were sent to Rome to be installed. The Pope, at a loss to decide which, appointed Stephen Langton, a learned Englishman. John retaliated, expelled the monks, and appropriated their revenues. Pope Innocent III., to punish him, laid England under an Interdict. The churches were closed, and the religious ceremonies suspended for a period of eight years (1205-13). As John showed no signs of submission the Pope excommunicated him, and finally absolved his subjects from their oath of allegiance, and called upon the King of France to take England. John, now thoroughly scared, agreed to submit, and Pandulph Pope's legate was sent to England to receive John's homage. England now was tributary to the Pope, to whom John annually paid a fee.

3rd. Magna Charta, *i.e.* Great Charter, 1215. The Barons, indignant at John's submission, with Fitz Walter at their head, demanded an interview with the King. They appeared, clad in armour, with armed retainers, asking for the King's signature to a bill which they had drawn up. The crafty King saw that it would greatly lessen his authority, and refused to comply. Unwillingly he was forced to add the Royal signature. After it was done he got the Pope to annul it, but with all his intrigues the Charter remained firm. The people, clergy, and barons were all greatly benefited by it, and it is generally regarded as the foundation of an Englishman's liberty.

[*Jimmy*]

2. Give a summary of the principal incidents in the wars carried on by the Plantagenet Kings against Ireland, Wales and Scotland.

Ireland.—Dispute between various Kings in Ireland caused the King of Leinster to seek help of Henry II. Strongbow, Earl of Pembroke, sent over, 1170. He married the heiress of Leinster, and became very powerful. Henry, jealous of his success, crossed the St. George's Channel and landed at Waterford, 1171. Making his way to Dublin he there received the homage of the Kings and was acknowledged Lord of Ireland, 1172.

Wales.—Edward I. invaded Wales, 1282. Prince Llewelyn had helped Simon de Montfort in preceding reign, and Edward resolved to punish him. Llewelyn slain at Builth, 1282. Edward II., born at Carnarvon Castle, 1284, was received by the Welsh chiefs as Prince of Wales.

Scotland.—Henry II.'s reign. William, the Lion of Scotland, invaded England, and taken prisoner at Alnwick, 1174. Released on payment of a ransom, and surrendering the fortresses of Edinburgh, Berwick, and Roxburgh.

Edward I. set about conquering Wales and Scotland. He succeeded with the former, and if he had lived longer no doubt Scotland would have been under his control. He gained the Battle of Dunbar, 1296; but Scotland found an able leader in Sir William Wallace, who won Stirling Bridge, 1297. The Battle of Falkirk, 1298, resulted in the defeat of Wallace. Shortly afterwards he was betrayed by Sir John Monteith, and executed on Tower Hill, 1305. The death of the English King, 1307, put an end to the war.

Edward II. remained inactive, while the Scots steadily recaptured all their lost territory. At last he gathered an army of 100,000 men, and was met at Bannockburn, and routed by Robert Bruce, 1314. Scotland gained her independence.

Edward III.—Three campaigns were carried on in this reign. The Battle of Halidon Hill was gained by Edward, 1333, and the Scotch suffered great loss. David II., King of Scotland, was taken prisoner at the Battle of Neville's Cross, 1346. Queen Philippa led the army, as Edward was in France.

Richard II.—Otterburn fought by Earl Percy, 1388. There was no decisive result to this war.

[*Jimmy*]

3. What important features characterise the condition of England under the Government of Queen Elizabeth?

Under Elizabeth England grew to be a thriving and prosperous nation. Many Foreign Protestants fled to England from the persecution on the Continent, and introduced new manufactures. The Protestant religion was firmly established, and Elizabeth was regarded as the champion of Protestantism in Europe. The days of the Feudal system were over, and every man was trained to arms. The defeat of the Armada, 1588, showed that England could defy the chief Powers of Europe in battle. Commerce flourished. Ships from America brought rare woods and precious stones, the countries of the Baltic sent furs, timber, and wheat. India's riches were brought forth, and in return England sent her manufactured stuffs. Sir F. Drake was the first Englishman who sailed round the world, and Sir W. Raleigh laid the foundation of American colonisation.

[*Jimmy*]

Teaching.

Describe the various means you would adopt to ensure good spelling in a class.

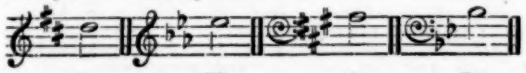
Spelling should follow reading. The teacher must not expect a child to follow a passage in dictation if he cannot read it. It is not so much the length of words as the irregularity of sounds which baffle beginners. Succeed, recede, plough, though, thought, through, tough, all present irregularities in either spelling or sound. Silent letters very often prove great stumbling-blocks to young children. To remedy this fault good use should be made of the blackboard and slate. A dozen words may be written on the blackboard, which the children should repeat after the teacher, so as to secure correct pronunciation, and then copy on slate or paper, so as to accustom their eyes to the form of the word. Rules may be learnt, but these may prove more injurious than beneficial, owing to the amount of exceptions. A child may be taught that when ing is added to verbs ending in e, the e is left out, and that words ending in ll, when added to another syllable, drop one l, as almost, until, faithful, &c. Nouns ending in f and y form their plurals by changing the f and y into v and i and adding es. Rules of this kind should be taught. Before some words can be correctly written the meaning must be known, therefore to secure good spelling the meanings must be taught; *e. g.*, course, coarse, descent, decent, is, his, as, has, their, there, hear, here, year, ear, &c.

The Dictation exercises should be carefully corrected, and a few minutes at the close of each reading lesson may be employed in individual and simultaneous spelling. I would test spelling by a short passage of dictation out of the reading book which the class uses, or by asking the child to spell a few words containing irregular sounds, and others containing silent letters.

[*Jimmy*]

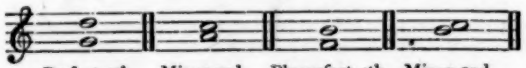
Music.

1. Below each of the following key signatures place the name of the keynote; and, in the space after each, place a minim in the position of the keynote:—



D E♭ A B♭

2. Place below each of the following intervals its name:—



Perfect 5th Minor 3rd Pluperfect 4th Minor 2nd

3. Write two measures of $\frac{3}{4}$ time.

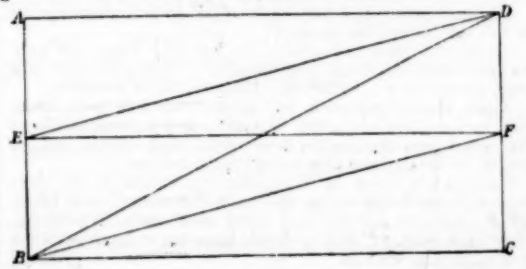
[*Jimmy*]

THIRD YEAR.

Euclid.

MALES.

1. Book I., Prop. 32.
2. Book I., Prop. 41.
3. From E and F the central points of two parallel sides of a parallelogram, ABCD, straight lines are drawn to the opposite angles B, D, respectively. Prove that EBFD is a parallelogram half the size of the given parallelogram.



Let EF be the middle points of AB, CD, two parallel sides of parallelogram ABCD.

Join ED, FB.

Then EBFD shall be a parallelogram = half parallelogram ABCD.

Join EF, BD.

∴ EB, DF, are equal and parallel straight lines (hypotenuse) and they are joined towards the same parts by straight lines ED, BF.

∴ ED, BF are equal and parallel (Euc. I. 33)

∴ EBFD is a parallelogram.

∴ △s DAE, DAB are on equal bases AE, EB, and between the same parallels AB, DC.

∴ △ DAE = △ DEB.

∴ △ DAB is double △ DEB.

Similarly △ CBD is double △ FBD.

∴ △s DAB, CBD together are double of △s DEB, FBD.

Now △s DAB, CBD together make up parallelogram ABCD and △s DEB, FBD together make up parallelogram EBFD.

∴ Parallelogram ABCD is double parallelogram EBFD, *i.e.*, parallelogram EBFD = half parallelogram ABCD.—Q. E. D. [*Gyp*]

Algebra.

1. Find the G.C.M. of $8ax^4 + 18ax^3 + 4ax^2 - 4ax - 8a$, and $9x^3y + 15x^2y - 3xy + 6y$.

$8ax^4 + 18ax^3 + 4ax^2 - 4ax - 8a$
$= 2a(4x^4 + 9x^3 + 2x^2 - 2x - 4)$.
$9x^3y + 15x^2y - 3xy + 6y$
$= 3y(3x^3 + 5x^2 - x + 2)$.

$3x^3 + 5x^2 - x + 2)\ 4x^4 + 9x^3 + 2x^2 - 2x - 4\ (4x + 7$

3
$12x^4 + 27x^3 + 6x^2 - 6x - 12$
$12x^4 + 20x^3 - 4x^2 + 8x$
$7x^3 + 10x^2 - 14x - 12$
3
$21x^3 + 30x^2 - 42x - 36$
$21x^3 + 35x^2 - 7x + 14$
$-5)\ -5x^2 - 35x - 50$
$x^2 + 7x + 10$

$x^2 + 7x + 10)\ 3x^3 + 5x^2 - x + 2\ (3x - 16$
$3x^3 + 21x^2 + 30x$
$-16x^2 - 31x + 2$
$-16x^2 - 112x - 160$
$81)\ 81x + 162$

$x + 2)\ x^2 + 7x + 10\ (x + 5$
$x^2 + 2x$
$5x + 10$
$5x + 10$
. .

∴ G.C.M. required is $x + 2$. Ans. [*Gyp*]

3. Solve the equations :—

(1.) $$\frac{2x - 5\frac{1}{2}}{7} + \frac{\frac{3}{4}x + 4}{2\frac{1}{2}} = \frac{\frac{3}{4}x - \frac{3}{4}}{\frac{3}{4} - \frac{3}{5}}$$

$$\frac{4x - 11}{2} + \frac{3x + 16}{4} = \frac{8x - 9}{12}$$
$$\frac{9 - 4}{6}$$

$$\frac{4x - 11}{14} + \frac{3x + 16}{10} = \frac{8x - 9}{10}$$

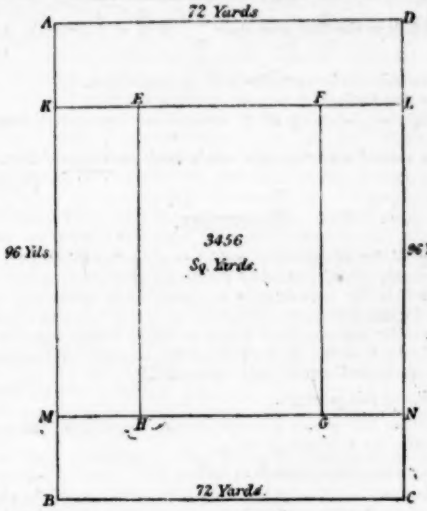
$20x - 55 + 21x + 112 = 56x - 63$
$-15x = -120$
$x = 8$. Ans. [*Gyp*]

(2.) $$\frac{x}{a} + \frac{x}{b} = \frac{1}{a^2b} + \frac{1}{ab^2}$$

$ab^2x + a^2bx = b + a$
$x(ab^2 + a^2b) = b + a$
$x = \frac{b + a}{ab^2 + a^2b}$
$= \frac{b + a}{ab(b + a)} = \frac{1}{ab}$ Ans. [*Gyp*]

Mensuration.

2. A rectangular plot measures 72 yds. by 96 yds. Half the area is occupied by a rectangular pond in the centre. Of what uniform width must the surrounding portion be?



Area of outside portion $= \frac{72 \times 96}{2} = 3456$ sq. yds.

Let x yds. = width of surrounding portion.

Then $2(72 \times x) = 144x$ = area of AL and MC together, and $2(96 - 2x)x = 192x - 4x^2$ = area of KH and FN together.

∴ $144x + 192x - 4x^2 = 3456$ sq. yds.
$36x + 48x - x^2 = 864$
$84x - x^2 = 864$
$x^2 - 84x = -864$
$x^2 - 84x + 1764 = 1764 - 864$
$x^2 - 84x + 1764 = 900$
$x - 42 = \pm 30$
$x = 12$ or 72

On trial, 12 satisfies the equation.

∴ width required is 12 yds. Ans. [*Gyp*]

Arithmetic.

FEMALES.

1. If the rent of 19 acres 3 roods is £96 15s. 6d., what will be the rent of 29 acres, 3 roods, 16 perches?

acres	roods		acres	roods	perches		£	s.	d.
19	3	:	29	3	16	::	96	15	6
4			4				20		
79 roods			119 roods				1935		
40			40				12		
3160 perches			4776 perches				23226		

$$\frac{597}{\frac{1194}{4776} \times \frac{3871}{23226}} = \frac{2310987}{15800} =$$
$$\frac{3160 \times 12 \times 20}{2 \quad 5}$$

£146 5s. $3\frac{3}{25}$d. Ans. [*Helena*]

2. Divide (·379 + ·0165 − ·042) by ·08484 =
,, (·3955 − ·042) by ·08484 =
,, ·3535 by ·08484 =

$\frac{·3535}{·08484} = 4·16$. Ans. [*Helena*]

3. Find the value of $1·571428$ of $18·2 \times \frac{11\frac{2}{3} + 2\frac{2}{14}}{1\frac{2}{0·3} - \frac{1·5}{4\frac{1}{2}}}$ of ·857142 of $12\frac{1}{2}$ guineas.

$$1\tfrac{571428}{1000000} \times 18\tfrac{2}{10} \times \frac{11\frac{2}{3} + 2\frac{2}{14}}{1\frac{2}{0·3} - \frac{1·5}{4\frac{1}{2}}} \times \tfrac{857142}{1000000} \times 12\tfrac{1}{2} =$$

$$1\tfrac{4}{7} \times 18\tfrac{1}{5} \times \frac{\frac{203}{18}}{\frac{91}{126}} \times \tfrac{6}{7} \times \tfrac{25}{2} =$$
$$8$$

$$\frac{\cancel{56} \quad \cancel{3} \quad 5}{11 \times \cancel{91} \times \cancel{392} \times \cancel{126} \times \cancel{6} \times \cancel{25}} =$$
$$\cancel{7} \times \cancel{5} \times \cancel{126} \times \cancel{91} \times \cancel{7} \times \cancel{2}$$

1320 guineas or £1386. Ans. [*Helena*]

4. One man can finish a piece of work in 13½ days. He works at it alone for 6 days, and is then joined by another. After working together for three days, the work is finished. In how many days could the second man have done it alone?

In one day the first man does $\frac{2}{27}$ of whole work.

$\therefore$ In 6 days the first man does $\frac{2}{27} \times \frac{2}{6} = \frac{4}{9}$ of whole work.

$\therefore$ $\frac{5}{9}$ remains to be done by both in three days.
In one day both do $\frac{5}{9} \div 3 = \frac{5}{27}$ of the whole.
Then $\frac{4}{27} - \frac{5}{27} = \frac{1}{27}$ or $\frac{1}{9}$, work done by second man in 1 day.
$\therefore$ the second man could do whole work in 9 days. Ans.

[*Helena*]

Grammar.

1. 'By this heavy discharge, *which continued as thick* and sharp *as hail, while, notwithstanding* every arrow had its individual aim, *they* flew by *scores together* against each embrasure and opening in the parapet, as well as at every window where a defender *either* occasionally *had post* or might be suspected to be stationed—by this sustained *discharge* two or three of the garrison *were slain*, and several *others wounded*.'

Paraphrase this passage.

2. Analyse the above passage into its constituent sentences, and describe the relations of each.

3. Parse the words printed in italics.

4. Select the words of Latin origin from the above passage, and state by what characteristics you make the selection.

1. Paraphrase.—Several of the archers had found something to shoot at, but the others, not having any special mark at which to aim, sent their arrows by scores together against any opening there might chance to be in the wall.

So thickly and sharply did the arrows fly, that many of the besieged were slain, and several wounded.

2. (*a*) Prin. Sen.—

Subject and Enlarg.	Two or three of the garrison
Predicate	were slain
Extension of	by this heavy discharge—
Instrument	by this sustained discharge.

(*b*) Prin. Sen. co-or. with (*a*)—

Connective	And
Subject	several others
Predicate	(were) wounded
Extension of	by this heavy discharge—
Instrument	by this sustained discharge.

(*c*) Sub. Adj. Sen. to 'discharge'—

Subject	Which
Predicate	continued
Ex. of Man.	as thick and sharp.

(*d*) Sub. Adv. of Degree to 'thick and sharp'—

Connective	As
Subject	hail
Predicate	(is thick and sharp)

(*e*) Sub. Adv. of Time to (*a* and *b*)—

Connective	While
Subject	they
Predicate	flew
Ext. of Man.	by scores together
1st Exten. of Place	against each embrasure and opening in the parapet
2nd Exten. of Place	as well as at every window.

(*f*) Sub. Adj. to 'window'—

Connective	Where either
Subject	a defender
Predicate	had
Object	post
Ex. of Man.	occasionally

(*g*) Sub. Adj. to 'window'—

Connective	Or
Subject	a defender
Predicate	might be suspected
Ind. Obj.	to be stationed

(*h*) Sub. Adv. of Reason—

Connective	Notwithstanding
Subject	every arrow
Predicate	had
Object	its individual aim.

3. *Which*—rel. pron., neu., sing., 3rd, agree. with its antecedent 'discharge,' nom., sub. to 'continued.'
continued—verb reg. (continue, continued, continued), intrans., indic., past., 3rd, sing., agree. with 'which.'
as—adverb of degree mod. 'thick.'
thick=thickly—adverb of man. mod. 'continued.'
as—adversative conjunction.
hail—noun com., neu., sing., 3rd, nom. to 'is.'
while—adversative conjunction.
notwithstanding—adversative conjunction.
they—per. pron., neu., plu., 3rd, nom., sub. to 'flew.'
scores—collec. noun., neu., plu., 3rd, obj. after 'by.'
together—adverb of man. mod. 'flew.'
either—distributive conjunction.
had—verb reg. (have, had, had), trans., indic., past, 3rd, sing., agree. with 'defender,' and gov. 'post.'
post—noun abs., neu., sing., 3rd, obj., gov. by 'had.'
discharge—noun abs., neu., sing., 3rd., obj. after 'by.'
were—aux. verb of passive voice.
slain—past part. of the irreg. trans. verb 'to slay' (slay, slew, slain), predic. of 'two or three.'
others—pron. used as a noun com., com., plu., 3rd, nom., sub. to '(were) wounded.'
wounded—past part. of the reg. trans. verb (wound, wounded, wounded), pred. of 'others.'

[*Helena*]

4. Discharge, from *dis* asunder.
Continued, from *con* together, *teneo* to hold.
Individual, from *in* not.
Parapet, from *paro* to prepare, *pectus*.
Defender, from *defendo* to ward off.
Occasionally, from *oc* in the way, *cado casum* to fall.
Suspected, from *sus* under, *specio spectum* to look.
Stationed, from *statio* to stand.
Sustained, from *sustineo* to uphold, to bear.
These words are selected because of their prefixes and affixes, and also because of their likeness to the Latin root.

[*Selina*]

Geography.

2. Describe, with a reasonable amount of detail, a journey up one of the great rivers of Africa to the interior of the continent.

If we intended taking a journey up the river Nile, we should start from Alexandria, which is the capital of Lower Egypt, and its chief port. Here we should see the famous Pompey's Pillar. Sailing on for two or three hundred miles along the famous canal, cut by order of Mehemet Ali in 1819, we should come to Cairo, and from this point of the river we should catch a glimpse of the Pyramids. The river is here about a mile in width. Continuing our course we should pass many interesting scenes, as the magnificient ruins and monuments of Dendera and Thebes. About a hundred miles above Thebes, we reach the first cataract of the Nile (there are seven in number). We now enter the territory of Nubia, which presents considerable modifications in the scenery. For the most part the river is shut in by hills of granite and sandstone. The valley between these is arid, barren, and sunbaked. A few stunted palms are the only traces of vegetation to be seen. We now find ourselves in an almost unknown part as regard history. We pass many ruins of towns, and temples, but the Nile itself is the greatest marvel. We are about 800 miles from the sea, and the next important place is Ipsambul. Here, on the confines of a pathless and unpeopled desert, stands one of Egypt's greatest marvels, 'The Temple of the Sun' built by Rameses, 1618 B.C. A few miles further on, the river makes a great bend, and flows past the noted town of Khartoom, in which, a short time ago, the interest of every Briton, and many others was centred. Beyond this, navigation is impossible, and there is nothing but a large tract of sand. The Nile rises in the Albert Nyanza and Victoria Nyanza, the two most important lakes in Africa.

[*Selina*]

3. Describe the physical features of Central Asia?

Mountains of Central Asia.—The mountains which surround Central Asia have the highest peaks in the world. As the Himalaya Mts. which bound Central Asia on the south, the highest peaks of which are Mt. Everest, 29,000 ft., and Karakoram, 28,278 ft. The Hindoo-Koosh, Bolor-Tagh, and the Ural Mts., bound Central Asia on the west, Stanovoi Mts. on the north, Yabloni Mts. on the east, Peling, Nanling, and Yunling on the south. The mountains running through the centre are, Kuenlun Mts., Thian Shan Mts., Tangri-shan Mts., Altai and Alatau Mts., Khing-gan Mts., Inshan and Nan-shan Mts.

Rivers of Central Asia.—Obi with its tributary the Irtish, Yenisei with its tributary the Angara, Lena with its tributary the Vitim, in the north. Amoor with its tributaries the Angari and Ussuri. Yangtse-kiang, Hoang-ho, and the Peiho in the east. Sanpoo or Brahmapootra in the south. Amoo or Oxus, Jaxartes or Sir-daria in the west. Those draining the centre are Tarim formed by the Cashgar and Yarkand, flows into Lobnor, Ili flows into the Balkash, Jabkan, and Selenga.

Lakes of Central Asia.—The principal are Baikal, the largest fresh water lake in Asia, Kossgol on the Angara, Tchany and Zaisan, on the Irtish, Balkash, Issikul, Alaktu, Ubsa, Iki-aral, Lob-nor, and Kokonoor in the central Plateau, and Tengri and Palte in Tibet.

[*Selina*]

Arithmetic.

MALES.

1. Extract the square root of 6·249; give the answer as a decimal.

$6\cdot249 = 6\cdot249$

$\underline{24}$

$6\frac{225}{999}\ \frac{1}{4} = 6\frac{1}{4} = \frac{25}{4}\quad \sqrt{\frac{25}{4}} = \frac{5}{2}$

$\frac{5}{2} = 2\frac{1}{2}$; $2\frac{1}{2} =$ 2·5. Ans. [*Competitor*]

2. If I sell £5000 out of the 3 per cents. when they are at 84, and invest the proceeds in 4 per cents. at 96, how is my income affected?

100 : 5000 :: £84 = £4200

$\underline{50}$

4200

100 : 5000 :: £3 = £150

$\underline{50}$

150

96 : 4200 :: £4 = £175

24 175

£175 − £150 = £25

Gain £25. Ans. [*Competitor*]

3. Divide £594 in proportion to the products 3×7, $4\frac{1}{2} \times 4\frac{1}{2}$, $22 \times \frac{3}{4}$.

$3 \times 7 = 21$; $4\frac{1}{2} \times 4\frac{1}{2} = 20\frac{1}{4}$; $22 \times \frac{3}{4} = 13\frac{3}{4}$

$21 + 20\frac{1}{4} + 13\frac{3}{4} = 55$ £594 ÷ 55 = $10\frac{4}{5}$

$10\frac{4}{5} = \frac{54}{5}$; $\frac{54}{5} \times \frac{21}{1} = 226\frac{4}{5}$; $\frac{54}{5} \times \frac{81}{4} = 218\frac{7}{10}$; $\frac{54}{5} \times \frac{33}{4} = 148\frac{1}{2}$.

£$226\frac{4}{5}$ = £226 16s., £$218\frac{7}{10}$ = £218 14s., £$148\frac{1}{2}$ = £148 10s.

£226 16s., £218 14s., and £148 10s. Ans.

[*Competitor*]

4. The difference between the simple interest and true discount on a certain sum in one year at 4 per cent. is £2. What is the sum?

104 : 100 :: 4 = £3 16s. $11\frac{1}{13}$d.

£4 − £3 16s. $11\frac{1}{13}$d. = 3s. $0\frac{12}{13}$d.

3s. $0\frac{12}{13}$d. : £2 :: $100 = \frac{100}{1} \times \frac{480}{1} \times \frac{13}{480} = 1300$

£1,300. Ans. [*Competitor*]

History.

MALES AND FEMALES.

1. What led to the Civil War? Relate the principal incidents in the course of the war.

The Civil War commenced in the reign of Charles I., Oct. 23rd, 1642. Charles wanted to have absolute power, and this led to continual disputes with his parliament. The parliament, in 1641, drew up a remonstrance complaining of the King's government. He made fair promises, but did not keep them, and soon ordered five of his most daring opponents to be arrested for high treason. The Commons refused to give them up, and demanded that the King should give up the command of the army. He refused, and the Civil War began. The King's soldiers were called Cavaliers, and the Opposition, or Parliament, Roundheads. The first battle was fought at Edgehill in 1642, but it decided nothing. In 1643 the Royalists took Bristol, and in the same year the battle of Newbury was fought in which the Roundheads were victorious. 21,000 Scottish troops crossed the border in 1644 to help the Roundheads. On July 2nd, 1644, the Royalists were defeated at Marston Moor, chiefly by Cromwell, and his Ironsides, as his soldiers were called. The immediate result of the victory was the capture of York and Newcastle by the Roundheads. In the same year (1644), a second battle was fought at Newbury ending in the defeat of Charles. The decisive battle of the Civil War was fought at Naseby in Northamptonshire in 1645, in which the Royalists were utterly routed. Charles then threw himself upon the mercy of the Scots, but was soon after given up to the English by his own desire, and was beheaded at Whitehall, Jan. 30th, 1649. [*Selina*]

2. What events are associated with the following places?—Sedgemoor, Glencoe, Preston Pans, Londonderry, Plassey, Sebastopol, Cawnpore, Navarino, Quebec.

Sedgemoor was the scene of the last battle fought on English ground, 1685. It was between the Duke of Monmouth, an illegitimate son of Charles II. who tried to obtain the throne, and James II. Monmouth was defeated and executed.

Glencoe is famous for the massacre of Glencoe in 1692. William III. issued an order that the Scottish Chiefs were to take an oath of allegiance before the last days of the year 1691. Mac-donald delayed, but repented during the last days of 1691, took the oath, and thought he was safe. A few weeks later all the inhabitants of Glencoe were massacred. This was done out of revenge by the Duke of Bredalbane, Feb. 13th, 1692.

Preston Pans.—Charles Stuart, the young Pretender, son of James the Pretender, and grandson of James II., attempted to gain the throne, but was met at Preston Pans in 1745. The royal army was entirely defeated.

Londonderry is noted for the siege in 1689 by James II. It was relieved by William III.

Plassey is famous for the battle of Plassey in 1757. It was gained by Lord Clive, and it gained for Britain the ascendancy over India.

Sebastopol is famous for a battle fought during the Russian war in 1854.

Cawnpore.—The Indian Mutiny broke out in 1857, during which one of the native chiefs, Nana Sahib, massacred a great number of Europeans, including women and children, at Cawnpore in 1857. Colonel Havelock marched to Cawnpore, and utterly defeated him.

Navarino is the port where the combined forces of the English, French and Russians destroyed the Turkish fleet, and compelled the Turks to acknowledge the Grecian independence.

Quebec is famous for the capture of Quebec in 1759, by General Wolfe. At that time the French held Canada, but this battle gained for the British the ascendency in Canada.

[*Selina*]

3. State briefly the circumstances under which our American colonies came into British possession, and also those under which a large portion was lost.

North America was at one time held by the French, while the British settlers possessed the coast of that territory now called the United States. The natural boundary was St. Lawrence, and its lakes, but the French insisted on building a change of forts from the lakes to the Mississippi, in order to shut out the British from the fur trade with the Indian tribes. The British settlers objected to it, and resorted to arms. Several of the French forts fell before the British, until the capture of Quebec in 1759 by General Wolfe gained for the British the ascendency in Canada.

The great American War by which England lost many of her American Colonies, began in 1765, in the reign of George III. In order to pay the expenses of a late war, the English resolved to tax tea and other goods which were sent to America. The English settlers refused to have them, and rose in arms. A petition was sent to George III., asking him to remove the tax, but it was refused. The first battle was fought at Lexington, in 1775, and then several others were fought with varying success until, in 1783, thirteen of the American colonies were severed from the British Empire. The independence of the United States was then formally acknowledged by treaty, and they became a Republic governed by a President. [*Selina*]

Teaching.

Write notes of a lesson on Iron and its uses.

MATTER.	METHOD.
Iron is a metal. The most important one we have. When found in its native state it is like a piece of dark brown sandstone.	Show why it is the most important of our metals. Give some idea of how it is found (like coal in strata) by a diagram on the blackboard.

MATTER.	METHOD.
Where found.—It is found in almost every country in the world; the chief are—Great Britain, Norway, Sweden, Belgium, France, and Russia (in Europe), India (in Asia), and the United States.	Write these names on the blackboard and have the countries pointed out on a map of the world. Give the children some idea of an iron mine by comparing it to a coal mine and by a diagram of shafts, etc., on the blackboard.
Smelting.—We could not utilize it if it remained in its native state, so we have to refine or smelt it. This branch of the trade is invariably carried on, on a coalfield. The iron smelting districts of England are on the South Wales, South Staffordshire and North Yorkshire coalfields.	Explain the process of smelting by a diagram of a blast furnace; and show how first a layer of coal, then iron ore, and lastly limestone are piled one upon another until the top of the chimney is reached. The furnace is then kindled and the iron ore melted. Show why it is carried on, on a coalfield. Write the names of the places mentioned, on the blackboard.
Kinds.—(1) cast iron; (2) wrought iron; (3) steel. Cast iron is hard and brittle. Wrought iron is strong and tough. Steel is refined iron.	Write these on the blackboard and explain how these different kinds are produced. Show what the different kinds are used for.
Where manufactured.—The chief towns where iron goods are made are: Birmingham Sheffield Walsall Wolverhampton St. Etienne and Namur.	Write down these names on the blackboard; and as they are all in Europe, point them out on that map. Show, too, that these places are all in the centre of a coalfield.
Uses.—It is of great utility. It is used in every branch of trade in some form or other.	Question the class as to a few of its chief uses, and put them on the blackboard under the following heads: (1) Building purposes. (2) Constructing machinery (3) Workmen's tools. (4) Articles for domestic use.
Recapitulation.	Repeat the headings and principal facts. Then clean the blackboard and question the class.

[*Competitor*]

Music.

1. Write the names of the following intervals:—

Minor Sixth — Major Third — Major Sixth — Major Second — Perfect or Major Fifth

2. Write two measures of $\frac{3}{4}$ time, introducing crotchets, quavers, dotted notes, and a rest.

3. What do the following signs indicate?—*pp.*, *ff.*, *cres.*, *dim.*, *staccato*.

pp.	very soft.
ff.	very loud.
cres.	gradually getting louder.
dim.	gradually getting softer.
staccato	cut short.

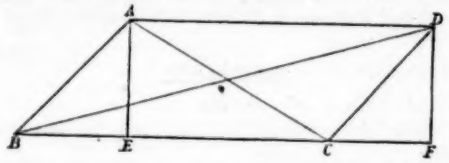
[*Helena*]

FOURTH YEAR.

Euclid.

MALES.

1. Book II., Prop. 2.
2. Book II., Prop. 9.
3. The squares on the diagonals of a parallelogram are together equal to the squares on the four sides.



From A and D draw AE, DF perpendicular to BC, or BC produced. (I. 12.)

Then in the triangles ABE, DCF, since the angles ABE, AEB, and side AB equal to angles DCF, DFC, and side DC. Therefore BE is equal to CF. (I. 26.)

The square on BD is equal to the squares on BC, CD together with twice the rect. BC, CF. (II. 12.)

The square on AC, together with twice the rect. BE, BC is equal to squares on AB and BC.

Adding the equals, the squares on BD and AC, together with twice the rect. BE, BC, are equal to squares on BC, CD, AB, BC, together with twice the rect. BC, CF.

Twice the rect. BE, BC, is equal to twice the rect- BC, CF, for BE is equal to CF.

The remainder, squares on BD and AC, is equal to squares on BC, CD, AB, BC, that is, squares on BC, CD, AB, AD.

[*Viscount Regis.*]

Algebra.

2. If $\frac{a}{b} = \frac{c}{d}$ prove that $\frac{a^2 - b^2}{c^2 - d^2} = \frac{ab}{cd}$.

If $\frac{a}{b} = \frac{c}{d}$, then subtracting from each side unity

$$\therefore \frac{a}{b} - 1 = \frac{c}{d} - 1 \quad \therefore \frac{a-b}{b} = \frac{c-d}{d}$$

Again, if $\frac{a}{b} = \frac{c}{d}$ $\therefore$ dividing unity by each side

$$1 \div \frac{a}{b} = 1 \div \frac{c}{d} \quad \therefore 1 \times \frac{b}{a} = 1 \times \frac{d}{c} = \frac{b}{a} = \frac{d}{c}$$

Adding unity to each side of this equation

$$\therefore \frac{b}{a} + 1 = \frac{d}{c} + 1 \quad \therefore \frac{a+b}{a} = \frac{c+d}{c}$$

And it was shown that $\frac{a-b}{b} = \frac{c-d}{d}$

$\therefore$ multiplying equals by equals

$$\frac{a+b}{a} \times \frac{a-b}{b} = \frac{c+d}{c} \times \frac{c-d}{d}$$

$$\therefore \frac{a^2 - b^2}{ab} = \frac{c^2 - d^2}{cd}$$

Again multiplying each side of the equation by $\frac{ab}{c^2 - d^2}$

$$\therefore \frac{a^2 - b^2}{ab} \times \frac{ab}{c^2 - d^2} = \frac{c^2 - d^2}{cd} \times \frac{ab}{c^2 - d^2}$$

$$\therefore \frac{a^2 - b^2}{c^2 - d^2} = \frac{ab}{cd}$$

[*Barnum*]

3. Solve the equations:

(1) $\frac{10x}{3} + \frac{2y}{15} = 14$, $\frac{22x}{3} - \frac{y}{6} = \frac{57}{2}$.

(2) $x^2 - 25x + 161 = 11$.

(3) $\frac{x-1}{\sqrt{x-1}} = x + \frac{5}{4}$.

$$\left.\begin{aligned} \frac{10x}{3} + \frac{2y}{15} &= 14, \\ \frac{22x}{3} - \frac{y}{6} &= \frac{57}{2} \end{aligned}\right\} \begin{matrix} (1) \\ (2) \end{matrix}$$

$\therefore$ multiplying (1) by 15, and (2) by 12

$$\left.\begin{aligned} 50x + 2y &= 210 \\ 88x - 2y &= 342 \end{aligned}\right\} \begin{matrix}(1)\\(2)\end{matrix}$$

By addition $138x = 552$.

$\therefore x = \frac{552}{138} = 4$.

$50x + 2y = 210$.

$\therefore (50 \times 4) + 2y = 210$

$\therefore 2y = 210 - 200 = 10$

$\therefore y = \frac{10}{2} = 5$.

$$\left.\begin{aligned} x &= 4 \\ y &= 5 \end{aligned}\right\} \text{ Ans.}$$

$x^2 - 25x + 161 = 11$

$\therefore x^2 - 25x = 11 - 161 = -150$

$\therefore x^2 - 25x + \left(\frac{25}{2}\right)^2 = \left(\frac{25}{2}\right)^2 - 150 = \frac{625 - 600}{4} = \frac{25}{4}$

$\therefore x - \frac{25}{2} = \pm \frac{5}{2}$

$\therefore x = \frac{25 + 5}{2}$ or $\frac{25 - 5}{2} = \frac{30}{2}$ or $\frac{20}{2} = 15$ or 10.

$\frac{x - 1}{\sqrt{x} - 1} = x + \frac{1}{4}$.

$\therefore \frac{(\sqrt{x} + 1)(\sqrt{x} - 1)}{\sqrt{x} - 1} = x + \frac{1}{4}$.

$\therefore \sqrt{x} + 1 = x + \frac{1}{4}$.

$\therefore \sqrt{x} = x + \frac{1}{4} - 1 = x + \frac{1}{4}$.

(Squaring) $\therefore x = (x + \frac{1}{4})^2 = x^2 + \frac{x}{2} + \frac{1}{16}$

$\therefore -x^2 + x - \frac{x}{2} = \frac{1}{16}$.

$\therefore x^2 - \frac{x}{2} = -\frac{1}{16}$.

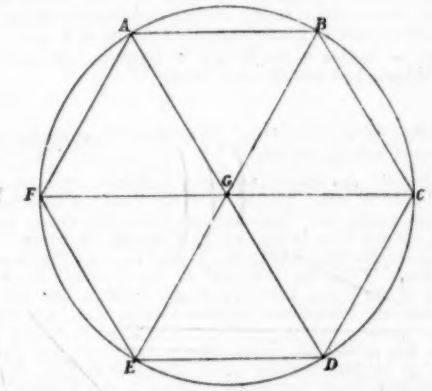
$\therefore x^2 - \frac{x}{2} + (\frac{1}{4})^2 = (\frac{1}{4})^2 - \frac{1}{16} = \frac{1}{16} - \frac{1}{16} = 0$.

$\therefore x - \frac{1}{4} = 0$. $\therefore \underline{x = \frac{1}{4}}$. Ans.

[*Barum*]

Mensuration.

1. The side of a hexagon measures 3 feet, find its area to the hundredth of a square inch.



Let ABCDEF be the given hexagon. Draw the diagonals each side of the hexagon = 3 feet. Since the length of the side of a hexagon = the length of the radius of the circumscribed circle $\therefore$ each of the radii in the figure GA, GB, etc. = 3 feet. And because in the triangles FGA, AGB, the sides FG, GA = AG, GB, and the base FA = AB $\therefore$ triangle FAG = AGB. Similarly, it may be shown that all the triangles are equal. $\therefore$ Area of hexagon = 6 times area of one triangle. Take the triangle FAG. Half sum of sides

$= \frac{3 + 3 + 3}{2} = \frac{9}{2} = 4\frac{1}{2}$. Hence, area of triangle

$= \sqrt{4\frac{1}{2}(4\frac{1}{2} - 3)(4\frac{1}{2} - 3)(4\frac{1}{2} - 3)} = \sqrt{4\frac{1}{2} \times 1\frac{1}{2} \times 1\frac{1}{2} \times 1\frac{1}{2}}$.

Hence, area of hexagon $= 6\sqrt{3} \times (1\frac{1}{2})^2 \times (1\frac{1}{2})^2$

$= 6 \times 1\frac{1}{2} \times 1\frac{1}{2} \times \sqrt{3} = 6 \times \frac{3}{2} \times \frac{3}{2} \times \frac{1{\cdot}732}{1}$

$= \underline{23 \text{ sq. feet } 55.008 \text{ sq. ins.}}$ Ans.

[*Barum*]

Arithmetic.

FEMALES.

1. In what time will £950 amount to £1199 7s. 6d., at $5\frac{1}{4}$ per cent. per annum simple interest?

Interest on £950 = £1199 7s. 6d. − £950 = £249 7s. 6d. £100 gains £$5\frac{1}{4}$ interest in 1 year. $\therefore$ Time required by £950 to gain £$249\frac{3}{8}$ =

$$\frac{1 \text{ yr.} \times 249\frac{3}{8} \times 100}{5\frac{1}{4} \times 950} = \frac{1 \times \overset{5}{\cancel{1995}} \times \overset{1}{\cancel{100}}}{\underset{21}{\cancel{42}} \times \underset{19}{\cancel{950}}} = \frac{1}{1} \text{ or 5 years}$$

$\underline{5 \text{ years.}}$ Ans. [*Cecilia*]

2. Find the difference between simple interest and true discount on £1365 for 9 months, at 4 per cent. per annum.

Simple interest on £100 for 1 year £4

$\therefore$ Simple interest on £1365 for 9 mths. $= \frac{4 \times 1365 \times 9}{100 \times 12} =$ £40 19s. simple interest

True discount for 9 months at 4 per cent. $= \frac{\overset{3}{\cancel{4}} \times 9}{\underset{3}{\cancel{12}}} =$ £3.

True discount on £103 = £3

$\therefore$ True discount on £1365 $= \frac{3 \times 1365}{103} = \frac{4095}{103} =$ £39 15s. $1\frac{78}{103}$d. true discount.

Difference = £40 19s. − £39 15s. $1\frac{78}{103}$ = $\underline{\text{£1 3s. } 10\frac{25}{103}\text{d.}}$ Ans. [*Cecilia*]

3. Two towns are 10 miles apart. From each of them a person starts at noon to walk to the other. One person takes 5 paces while the other takes 6, and the length of the former's pace is to the latter's as 4 to 5. Where will they meet?

1st person's rate of walking = $5 \times 4 = 20$

2nd " " = $5 \times 6 = 30$

Ratio = 2 : 3 Ratios added together = 5

$\therefore$ They meet when the first person has gone $\frac{\overset{2}{\cancel{10}} \times 2}{\underset{1}{\cancel{5}}} = 4$ miles,

and when the second person has gone $\frac{\overset{2}{\cancel{10}} \times 3}{\underset{1}{\cancel{5}}} = 6$ miles.

When 1st person has gone 4 miles and 2nd person 6 miles. Ans.

[*Cecilia*]

4. A draper bought a piece of cloth measuring 52 yds. for £14 17s. 6d. Four yards were damaged, and had to be sold for 2s. 3d. per yd. At what price per yd. must he sell the remainder in order to clear 10 p. c. on the cost.

10 p. c. on £14 17s. 6d. $= \frac{\text{£14 17s. 6d.} \times 110}{100} =$ £16 7s. 3d.

Selling price of 4 yds. at 2s 3d. = 9s. 0d.

£16 7s. 3d. − £0 9s. 0d. = £15 18s. 3d. = selling price (gaining 10 p. c.) of 48 yards

$\therefore$ Selling price of 1 yd. = £15 18s. 3d. ÷ 48 = $\underline{6\text{s. } 7\frac{9}{16}\text{d. price of 1 yd.}}$ Ans.

[*Cecilia*]

Grammar.

MALES AND FEMALES.

1. 'Knowledge and wisdom, *far* from *being one*,
Have ofttimes no connection. Knowledge dwells
In minds *replete* with thoughts of other men,
Wisdom in minds attentive to *their own*;
Knowledge, a rude unprofitable mass,
The mere *materials* with which wisdom builds,
Till *smoothed* and squared and fitted to its place,
Does but encumber what it seems *t'enrich*.
Knowledge is proud *that* he has learned *so much*,
Wisdom is humble that he knows no more.'

Paraphrase this passage.

Knowledge and wisdom, instead of being synonymous terms, as is commonly supposed, often bear no relation to one another. Knowing other men's opinions and meditations constitutes knowledge, thinking for oneself, and having thoughts of one's own, wisdom. Knowledge is of little advantage to the possessor, until he makes use of that knowledge by thinking for himself.

The possession of knowledge may lead to the acquisition of wisdom, but, until wisdom is attained, it simply burdens the mind. Pride will be found to accompany knowledge; a wise person will think his knowledge insignificant when compared with what he does *not* know. [*Barum*]

2. Write out the subordinate sentences, and state the function and relation of each.

(*a*) *With which wisdom builds*—adjective sentence qual. 'materials' sub-ordin. to 'knowledge does encumber.'

[NOTE.—'What' in line 8 = that which.]

(*b*) *Which it seems to enrich*—adjective sentence qual. 'that' (1st part of 'what') sub-ordin. to 'knowledge does encumber that.'

(*c*) *That he has learned so much*—adverbial sentence, 'cause or reason' sub-ordin. to 'knowledge is proud.'

(*d*) *That he knows no more*—adverbial sentence of 'cause or reason' sub-ordin. to 'wisdom is humble.' [*Cecilia*]

3. Parse the words underlined, and make a list of those derived from the Latin language.

(*a*) *For*—adverb of place mod. 'being.'
being—imperfect participle of verb 'to be.'
one—def. num. adj. qual. 'thing' (understood).
replete—adj. of quality qual. 'minds.'
wisdom—prop. noun, mas. gen. (personified), 3rd per., sing. num., nom. case to 'dwells' (understood).
their—poss. adj. pro., neu. gen., 3rd per., plu. n., poss. case to 'thoughts' (understood).
own—poss. adj. pro., neu. gen., 3rd per., plu. n., poss. case to 'thoughts' (understood).
materials—com. noun, neu. gen., 3rd per., plu. num., nom. case in appos. to 'knowledge.'
smoothed—perfect participle of verb 'to smooth,' qual. 'knowledge.'
does—auxiliary of emphasis to 'encumber.'
but—adverb of manner mod. 'does encumber.'
does encumber—reg. tran. verb, act. voice., indic. mood. pres. emphatic tense, 3rd per., sing. num., agree. nom. 'knowledge,' gov. 'that' (part of 'which') in obj. case.
what = that—rel. pro., neu. gen., 3rd per., sing. num. (antec. of itself), objec. case after trans. verb 'does encumber.'
which—rel. pro., neu. gen., 3rd per., sing. num., agree. antec. 'that,' obj. case, after 'to enrich.'
to enrich—reg. trans. verb, infinitive mood, gov. 'which' in objec. case.
that—copulative conj. join. sent. 'knowledge is proud' and 'he has learned.'
so—adverb of degree mod. 'much.'
much—adjective of quantity qual. 'learning' (under.).
[*Cecilia*]

(*b*) Words derived from Latin:—
1. Connection, *con* and *necto*, I tie.
2. Mind, *mens mentis*, the mind.
3. Replete, *repleo*, I fill.
4. Attentive, *ad* and *tendo*, I stretch.
5. Unprofitable, *pro* and *facio*, I make.
6. Mere, *merus*, pure.
7. Materials, *materia*, matter.
8. Squared, *quadro*, I make square.
9. Fitted, *facio*, I make.
10. Encumber, *encombro*, I entangle.
11. Humble, *humilis*, on the ground. [*Snow*]

4. What principle guides you in arranging words under the parts of speech? Write sentences to exemplify the use of each of the following words as three different parts of speech:—After, but, near, over.

The principle by which one should be guided in arranging words under their parts of speech is that the *use* of a word determines its part of speech.

After.—He came *after* I did (conjunction).
He came *after* me (preposition).
I came first, he came *after* (adverb).

But.—He intended to come, *but* he was taken unwell (conj.).
'(Knowledge) does *but* encumber, *etc.*' (adverb).
No one was in the room *but* the master (preposition).

Near.—They were sitting *near* me (preposition).
W—— was a *near* relation of his (adjective).
He came *near* (adverb).

Over.—The south-west winds blow *over* the Atlantic (prep.).
The entertainment was *over* (adjective).
How did it get *over*? (adverb). [*Barum*]

Geography.

2. Write what you know of the following places:—Hong-kong, Yokohama, San Francisco, Brisbane, Quito, Khartoum, Auckland, Antananarivo, Kandy, Natal, Corunna, Aleppo, Sofia.

Hong-kong is a barren, mountainous island, at the mouth of the Canton river. Victoria, the capital, is beautifully situated on a splendid harbour on the north side of the island. Hong-kong is an important military and naval station, and it is the centre of great trade.

Yokohama is a port of Japan, near Kanagawa. It is a great centre of foreign trade and is the chief residence of English and other foreign merchants.

San Francisco is situated on a bay of its own, and south of the Golden Gate. It is the chief town in the Pacific States, and has great trade. It is connected by rail with the Eastern States.

Brisbane is a town on the east coast of Australia, and the capital of Queensland. It is an active sea port, and gradually increasing in importance.

Quito is a town in S. America just under the Equator, at an elevation of 9,500 feet. It enjoys a perpetual spring. It is subject to earthquakes. It is the capital of Ecuador.

Khartoum, at the junction of the White and Blue Nile, is famous for its siege and gallant defence by General Gordon. He was treacherously betrayed to the Mahdi.

Auckland is the name given to a district in New Zealand. It is also the name of the former capital of New Zealand. It is situated on an isthmus in North Island. It has a fine harbour.

Antananarivo is the capital of Madagascar, a large island on the east coast of Africa. It is situated on a high plateau in the interior.

Kandy is the ancient capital of Ceylon, an island to the south of India. It is situated in the interior.

Natal or Port Natal is the only large harbour of Natal, a district of South Africa. Its harbour however is obstructed by a bar. It exports the productions of Natal.

Corunna is a flourishing commercial port on the north-west coast of Spain. Here Sir John Moore was killed in 1808, after repulsing the French.

Aleppo is the principal city in northern Syria. It has suffered greatly from earthquakes. It has considerable manufactures and is the centre of much trade. Scanderoon is its port.

Sofia or Sophia is the capital of Bulgaria. It lies north of the Balkans, and near the river Isker.

[*Snow*]

3. Give an account of the distribution of volcanoes, and the regions of volcanic activity.

Volcanoes are mostly arranged in bands, and are chiefly found near the sea. The whole of the Pacific is bounded by a chain of volcanoes. Beginning at Tierra del Fuego (land of Fire), we find them in the Andes all through its course. From the Andes the band is continued in Mexico, and North-western America. They are continued to the continent of Asia by means of the Kurile Islands, and are found in the Islands of Formosa, the Philippines, Solomon Islands, and New Zealand. From Celebes a branch proceeds to Java, then to Barren Island in the Bay of Bengal. From Barren Island we may trace this band of volcanic activity to the Thian-shan Mts., or to the Archipelago, Italy, and Sicily, and on to the Canaries. The Thian-shan Mts. is the only region of volcanic activity far removed from the sea. Java is the most volcanic district in the world. About 400 volcanoes have been counted on the earth's surface.

[*Barum*]

Arithmetic.

MALES.

1. A certain sum placed out at simple interest for 3 years at 5½ per cent. per annum, brings in £18 8s. 9d. more in the 3 years than if it were placed out at compound interest for the same time at 5 per cent. per annum. What is the sum?

Suppose £100 to be the sum.
Then interest on £100 for 3 years at 5½ per cent. simple interest
$= (3 \times 5\frac{1}{2})$ £ = £16 10s. 0d.
and interest on £100 for 3 years at 5 per cent. compound interest
= £15 15s. 3d.
Therefore, Gain = (£16 10s. 0d.)—(£15 15s. 3d.) = 14s. 9d.

$$\therefore \text{As } 14s.\ 9d. : £18\ 8s.\ 9d. :: £100 : x$$

$$= \frac{100 \times 4425}{177} = £2,500. \text{ Ans.}$$

[*St. Peter's*]

2. A man has a ship worth £9,500. He insures it at 3¾ per cent., so as to cover the value of the vessel and the cost of insurance. What premium has he to pay?

The premium on £96¼ being £3¾, we derive the following proportion :—

$$\text{As } £96\tfrac{1}{4} : £9500 :: £3\tfrac{3}{4} : x$$

$$= \frac{15 \times 9500 \times 4}{4 \times 385} = \frac{142500}{77} = £370\ 2s.\ 7\tfrac{11}{77}d. \text{ Ans.}$$

[*St. Peter's*]

3. Explain clearly the method you adopt in division by a decimal fraction, and show how you would divide by a recurring decimal.

To divide by a decimal fraction multiply both dividend and divisor by such a power of 10 as will cause the divisor to become a whole number. Then proceed as in ordinary Long or Short Division, taking care that, when the decimal point is met with in the dividend to insert one in the quotient.

For example, ·86 ÷ ·0932.

The power of 10 required in this case to make the Divisor become a whole number is the fourth = 10,000.

Multiplying ·86 by 10,000, and ·0932 by 10,000 we get 8600 ÷ 932.

Then divide 8600 by 932, if necessary (and in this case it will be so), adding as many noughts to the dividend as may be required. Thus 8600·000, etc. ÷ 932.

In the case of a recurring decimal the decimal must first be brought to a vulgar fraction. Then, if required, the answer may be reduced from the vulgar to the decimal form.

For example ·405 ÷ ·136

$$= \frac{405}{1000} \div \frac{136-1}{990} = \frac{405}{1000} \times \frac{990}{135}$$

$$= \frac{297}{100} = 2{\cdot}97. \text{ Ans.}$$

[*Barum*]

4. One watch gains 4 minutes in 24 hours, another loses 2 minutes in 36 hours. They are both set right at noon. What is the real time when the difference between them is 15 minutes?

A gain of 4 minutes in 24 hrs. = a gain of $\frac{4}{24} = \frac{1}{6}$ min. in 1 hr.

A loss of 2 ,, 36 ,, = a loss of $\frac{2}{36} = \frac{1}{18}$,,

Hence, at the end of an hour after having been set right, the watches would show a difference of $\frac{1}{6} + \frac{1}{18} = \frac{4}{18} = \frac{2}{9}$ mins.

Since a difference of $\frac{2}{9}$ mins. represents 1 hour of time.

$\therefore$,, ,, $\frac{1}{2}$,, ,, $\frac{1}{2}$,,

$\therefore$,, ,, $\frac{15 \times 9}{9} = \frac{135}{9}$,, $\frac{135}{2}$,,

$= 67\frac{1}{2}$ hours.

$67\frac{1}{2}$ hrs. = 24 + 24 + 12 + 7 hrs. 30 mins.

Hence, real time, when the difference between the time as shown by the watches is 15 minutes = 7.30 a.m., on the morning of the third day after the watches have been set right.

[*Barum*]

History.

1. What eminent Englishmen engaged in the Crusades? Mention some of the effects which the Crusades had upon this country.

Robert Duke of Normandy, the son of William I. engaged in the first Crusade.

Richard I. was by far the most eminent Englishman who fought in the Crusades.

The next whom we read of was Edward I. (at that time Prince of Wales, as we should call him now,) and Edmund his brother. They fought in the last Crusade.

The worst effect which the Crusades had upon England was the great draining of money. The Crusaders looked to England as if it overflowed with money, consequently the country became very poor. Most of the nobles joined the Crusades, those who remained behind, harassed the poor people, and did just as they pleased, therefore the country was in a very disturbed state. The Crusades however opened out to us the East and our trade increased, and many customs and articles of dress were introduced and adopted. The travelling which they caused opened men's minds, and their ideas enlarged. [*Cecilia*]

2. State some of the facts which indicate the great material progress made by England during the present Queen's reign.

(*a*) Good laws have been passed. Such as the Repeal of the Corn Laws, the Penny Postage Act, the Reform Bills of 1867 and 1884, the Ballot Act, Land Bills for Ireland and many other good and noble laws.

(*b*) Inventions and other discoveries are numerous and are encouraged.

(*c*) The education of the children of the country is now carefully attended to, and the country is therefore getting more enlightened.

(*d*) Our literature during the present reign has become the purest in the world.

(*e*) The example set to the country by the sovereign has not been lost, and the morality of our country stands very high among other nations. [*Cecilia*]

3. What were the causes, the chief incidents, and the chief results of the continental war in the reign of Anne?

Causes.—The King of France was Louis XIV.; on the death of Charles, King of Spain, the crown of Spain went to a grandson of Louis, Philip by name. To prevent the union of two powerful countries William III. of England had formed an alliance with the other powers of Europe, and Louis refusing to give up this Spanish claim, war was declared against him.

Incidents.—The Duke of Marlborough was made the general of the allied armies, and joining the Emperor's general Prince Eugene, they marched into Bavaria. There they encountered the French army and the great battle of Blenheim was fought 1704. In the next campaign the battle of Ramillies (1706) was fought, and in the next the battle of Oudenarde. A very important incident was the capture of Gibraltar 1704 by Sir George Rooke, which England has retained ever since.

Results.—Peace was made at Utrecht (1813). By it England was allowed to retain Arcadia, now called Nova Scotia, Minorca, and Gibraltar. Louis agreed to recognise the claims of the House of Hanover to the English throne, and to dismiss the Pretender from his dominions. He also declared that the thrones of Spain and France should never be united. [*Cecilia*]

4. Name a dozen of the most important works in English literature, adding when and by whom they were written. Write more fully on any two of the works or authors.

Work	Author	When written
Fairie Queen	Edmund Spenser ...	1590-96
Hamlet	William Shakespere ...	about 1690
Essays	Lord Francis Bacon ...	1597
Paradise Lost	John Milton	1654-60
Pilgrim's Progress ...	John Bunyan	1678
Robinson Crusoe ...	Daniel Defoe	1719
Decline and Fall of the Roman Empire	Edward Gibbon ...	1776-87
History of England ...	Lord Macaulay ...	1848-59
The Excursion	William Wordsworth ...	1814
Kenilworth	Sir Walter Scott ...	about 1820
History of the French Revolution ...	Thomas Carlyle ...	1837
Idylls of the King ...	Lord Tennyson ...	1859-73
Pickwick Papers ...	Charles Dickens ...	1837

William Shakespere was born at Stratford-on-Avon in 1554. He was of humble origin and very little about his early life is known. He married at the age of eighteen Anne Hathaway, and when he was twenty-two he went to London. There he became part proprietor and an actor of the Globe Theatre. Having made a modest fortune he retired and lived in his native town, till his death in 1616.

Sir Walter Scott was born in 1771 at Edinburgh. He was educated for the law and he became an advocate. He abandoned this profession, and began writing poetry. His poems were received with such marked success, that he soon made a fortune. He built a house on the banks of the Tweed and lived there. Some unfortunate business speculations almost ruined him, and to free himself, he wrote the unrivalled series of Waverley Novels. His death was hastened by overwork and he returned home from Italy to his beloved Abbotsford to die in 1832. [*Cecilia*]

Teaching.

Write notes of a lesson on the Barometer, or on the Use of Mountains.

HEADS AND MATTER.

1. Mountains influence the climate of a country. In hot countries the parts which are elevated enjoy a much milder climate than the plains. Mountains keep off the very cold winds and moderate the hot winds.
2. They form excellent boundaries to countries, and people who live in mountainous countries are usually very brave and independent.
3. Most mountains contain minerals and the working of the minerals gives employment to many thousands of people in all countries.
4. Mountains afford pasture for numbers of all kinds of animals.
5. In mountains most of the rivers of the world take their source, and by thus diverting the streams they help to fertilize a country.
6. Mountains make a country look beautiful, and there is no scenery grander than that of mountains.
7. Mountains are such stupendous objects that they fill the mind with awe, and raise our thoughts to the Maker of the mountains and of us.

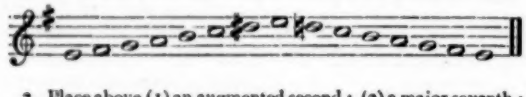
METHOD.

Introduce lesson by asking children what are the largest objects they have ever seen. Illustrate each head by referring to a globe or map of the world, pointing out Italy to show 1st head. Chili the 2nd, and Switzerland, Siberia and Peru the 3rd; Switzerland the 4th, the United States the 5th, and Wales and Scotland the 6th. Ask children about each country, draw from them all they know by questioning. Ask them to name some mountains which they have seen or read of, and if they have ascended a mountain let them say how they did it and what they saw. Summarize.

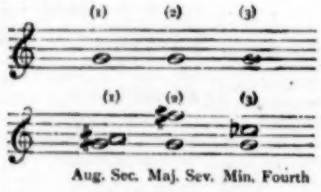
[*Cecilia*]

Music.

1. Write in the Treble clef the ascending scale of E minor, using the minor sixth and the major seventh, and the ordinary descending scale of E minor.



2. Place above (1) an augmented second; (2) a major seventh; (3) a minor fourth:—



Aug. Sec. Maj. Sev. Min. Fourth

3. Add proper time-signatures to the following:—

[*Snow*]

SECOND YEAR.

Arithmetic.

FEMALES.

1. Convert into decimals $\frac{41}{250}$, $\frac{275}{100}$, $\frac{492}{700}$, and $\frac{3\frac{1}{4}}{19\frac{1}{2}}$.

$$\frac{41}{250} = \frac{41 \times 4}{250 \times 4} = \frac{164}{1000} = \cdot164.$$
$$\frac{275}{100} = 2\cdot75.$$
$$\frac{492}{700} = 4\cdot\frac{92}{7} = \cdot70285714.$$
$$\frac{3\frac{1}{4}}{19\frac{1}{2}} = \frac{3\frac{1}{4} \times 4}{19\frac{1}{2} \times 4} = \frac{13}{78} = \frac{1}{6} = \cdot16.$$

$\cdot164$; $2\cdot75$; $\cdot70285714$; and $\cdot16$. Ans.

2. Simplify $\left\{\frac{1}{2} \text{ of } 3\frac{4}{17} \text{ of } 6\frac{9}{11} - \frac{3\frac{1}{6}}{1\frac{2}{3}}\right\} \div \frac{6\frac{7}{8} + 5\frac{2}{3}}{9\frac{5}{8} - 5\frac{1}{3}}$

Multiplying numerator and denominator of 1st complex fraction by 9, and of 2nd complex fraction by 24, we have

$$\left(\frac{1}{2} \text{ of } \frac{18}{17} \text{ of } \frac{75}{11} - \frac{31}{15}\right) \div \frac{165 + 136}{226 - 140}$$
$$= \left(\frac{1}{2} \times \frac{9}{17} \times \frac{75}{11} - \frac{31}{15}\right) \div \frac{301}{86}$$
$$= \left(\frac{675}{374} - \frac{31}{15}\right) \times \frac{86}{301}$$
$$= \frac{5625 - 1054}{510} \times \frac{2}{7} = \frac{4571}{255} \times \frac{1}{7}$$
$$= \frac{653}{255} = 2\frac{143}{255}. \text{ Ans.}$$

3. Out of a £5 note I spend $\frac{4}{15}$, $\frac{7}{12}$, and $\cdot01$, express the remainder as the decimal of £1.

$\frac{4}{15}$ of £5 = $\frac{20}{15}$ of £1 = £1$\frac{5}{15}$ = £1 6s. 8d.
$\frac{7}{12}$ of £5 = $\frac{35}{12}$ of £1 = £2$\frac{11}{12}$ = £2 18s. 4d.
$\cdot01$ of £5 = $\frac{1}{100}$ of £5 = 1s. 0d.

The sum of these three = £4 6s.
The remainder of £5 = 14s. = $\frac{7}{10}$ of £1 = £$\cdot7$. Ans.

4. $\frac{3}{8}$ of a farm is sown with wheat, $\frac{5}{14}$ with oats, and the remainder, 35 acres 3 roods, is pasture. What is the extent of the farm?

Part sown with wheat and oats = $\frac{3}{8} + \frac{5}{14} = \frac{14 + 10}{35} = \frac{24}{56}$
Remainder = $\frac{11}{56}$ of whole farm is pasture.
Since $\frac{11}{56}$ = 35 acres 3 roods,
$\frac{1}{56}$ = 35 ac. 3 rds. ÷ 11 = 3 ac. 1 rd.
And the whole = 3 ac. 1 rd. × 35 = 113 ac. 3 rds. Ans.

FOURTH YEAR.

Algebra.

1. Find the value of $\left(\frac{2x - a}{2x - b}\right)^2 - \left(\frac{a - x}{b - x}\right)$,

when $x = \frac{ab}{a + b}$

$$\left(\frac{2x - a}{2x - b}\right)^2 - \left(\frac{a - x}{b - x}\right)$$
$$= \left(\frac{\frac{2ab}{a + b} - a}{\frac{2ab}{a + b} - b}\right)^2 - \left(\frac{a - \frac{ab}{a + b}}{b - \frac{ab}{a + b}}\right)$$
$$= \left(\frac{2ab - a^2 - ab}{2ab - ab - b^2}\right)^2 - \frac{a^2 + ab - ab}{ab + b^2 - ab}$$
$$= \left(\frac{ab - a^2}{ab - b^2}\right)^2 - \frac{a^2}{b^2}$$
$$= \left(\frac{a(b - a)}{b(a - b)}\right)^2 - \frac{a^2}{b^2}$$
$$= \frac{a^2(b^2 - 2ab + a^2)}{b^2(a^2 - 2ab + b^2)} - \frac{a^2}{b^2}$$
$$= \frac{a^2}{b^2} - \frac{a^2}{b^2}$$
$$= 0. \text{ Ans.}$$

—o—

Query Column.

RULES.

1. Each correspondent is restricted to *one question*. We should be much obliged if correspondents, who send questions for solution, would give (if possible) the required answer, and the source from which the question is obtained.

2. No query can be answered unless accompanied by the real name and address of the sender, not necessarily for publication, but as a guarantee of good faith and for facility of reference.

3. ☞ **When a pseudonym is adopted it should be written at the end of the query, and the real name and address on a separate piece of paper.**

4. Correspondents are requested to write their queries *legibly*, and on one side of the paper only.

5. Replies will not be sent through the post.

6. Queries must reach the office *not later than the 12th of the month*, or they cannot be attended to in the following issue.

*** All communications for this column should be addressed—'*The Query Editor*,' *The Practical Teacher, Pilgrim Street, Ludgate Hill, London, E.C.*

General.

1. A. WHARTON.—The solution of your first query appeared in our issue for August, 1882, and the solution of the second in our issues for February, 1882, and July, 1884.

2. A SUBSCRIBER.—You will find the solution of your query in our issue for May, 1882.

3. HANNIBAL.—Your query was solved in our issue for April, 1884.

4. BARNSTAPLE.—Your handwriting is fairly good, and might gain 75 per cent. of marks. To improve it, practise carefully and endeavour to avoid a tendency to vary the slope, and the length of loops and long strokes. Small *d* is too short, as a rule. Do not attempt to alter your style, but only to perfect it.

5. HELOISE.—You do not say whether you refer to the papers for male or female candidates. There is no examination in arithmetic for male candidates; none in mental for females.

6. Y. B. G.—Letters are not of the right shape, thick strokes are uneven, joinings not good, the forms of the letters poor, the *r*, *g*, *s*, are exceedingly bad. For the scholarship, it is the worst we have seen. 30.

7. CONSTANT READER.—The Science certificates you have obtained will, we believe, count in your favour. You cannot be examined in them at Christmas. Political Economy is now taken in place of a language. As you cannot take them of course you cannot take Political Economy. See answer to *Ambleside*.

8. REX.—Upon entering a training college you make a declaration that you intend becoming a teacher in an elementary school. You do not state how long you will continue in the profession. In case you subsequently entered the Civil Service you would have to refund to the Government the sum it contributed to the cost of your college training. The Sciences taken at Westminster are Chemistry, Physiography, and Physics.

9. ANXIOUS.—We are not acquainted with the class you name. We draw your attention to the advertisements in last month's magazine. The Teachers appear to be remarkably successful.

10. COLL. CESTR.—We do not know of a cheap book of obsolete words and phrases.

There is no reliable epitome of psychology and ethics such as you would like. You need not read the whole of a large book like *Sully's*; but it would be useless and misleading to read a collection of quotations from different authors of different schools of thought. Study the lessons now appearing in this magazine and when you understand them, read the early chapters of *Sully's* 'Outlines of Psychology.'

11. SCHOLASTIC.—Thank you. There is something in what you say. It is not possible, however, for you to have had all the advertisements removed, and many people retain them all. We have done so. In any case there is no inconvenience. The matter will be considered.

12. SCIENCE.—We ought not to tell you how many marks; the number is large, only one or two other subjects bring more. For acoustics, light, and heat, try *Garnett's* 'Heat' or *Deschanel's* 'Light, sound, and heat.' The books you name are quite behind the best. A capital set of experiments is to be found in *Worthington's* 'Physical Laboratory Practice,' Rivingtons, but his book is not confined to your subject.

13. WM. HEATH.—What made you think that if the answers did not agree with those in the book you mention that they were wrong? We should advise you not to look into that key again. The answers we gave were perfectly correct. The number of ways in which you can arrange the things taken two at a time is $n(n-1)$. Let the things be the letters *a*, *b*, *c*, &c., then there would be $(n-1)$ letters in which *a* could be placed first and $(n-1)$ in which *b* could be placed first and of on of the remaining letters, hence the total number so arrangements would be $n(n-1)$. In the case of *a*, *b*, *c*, the arrangements would be *ab*, *ba*, *bc*, *cb*, *ac*, *ca*.

14. PENTREFIOR.—If you have a love for study, you can carry it on under any circumstances. Your list of books is good and ample. You would find *Collin's* 'School management' useful. If you wish to begin the other subjects you can ask for information. You should be able to do well with the list you already have.

15. IPSWICHIAN.—We suppose you have given a question that has been set at some examination. It takes for granted that you have read the two odes and are able to refer to them and quote them. It seems also that you have not read *Johnson's* criticisms. In his life of Pope he says in regard to these odes, 'Pope is read with calm acquiescence, Dryden with turbulent delight; Pope hangs upon the ear and Dryden finds the passes of the mind.' Johnson minutely compares the two odes on page 222 of the Clarendon Press edition.

16. GYRN.—Penmanship, large hand 80, small hand 90. 1. The composition is good. Its main fault is the want of simplicity. The subject is exalted and some dignity of language excusable. But don't be beguiled by long sounding words and phrases. When a more than usually eloquent phrase occurs to you, leave it out. Be natural and simple. Choose the shortest words that will express your meaning. 2. Don't *get up Jevon's* 1/- book or any other. Read the whole of it carefully and think about it and work the exercises. 3. Master the allusions, the grammar, the subjects treated, and the characters introduced.

17. AMBLESIDE.—We cannot tell you at present. Formerly the subjects you name carried fewer marks than some others. But one would imagine now the groups would be equally marked. Acting teachers who have not been examined in the previous year must take group (*c*) and (*d*). Hence you need not trouble about the question you ask.

18. AVRIL.—Value 75 large and 75 small. Large is too upright, joinings poor. Small hand is better, should be larger and have more slope.

19. J. HAGGART.—Prawle point is in Devonshire. The other name is not known to us. It is probably only of purely local importance. Don't trouble about the mint, anise and cummin.

20. HAREBELL.—Small hand is far too small and thick: large hand would be good if you would study some rules for writing as to height and joinings. Small 50, large hand 70.

21. BROAD ARROW.—(*a*) 95. (*d*) 95. (*b*) 90.

22. HIERO.—We really cannot say. You could not do wrong in aiming at a good degree. You should at the same time strive to become an able teacher. It is also essential that you should be a man of high character and have the spirit and manners of a gentleman.

23. PRELIM SC.—
Proceed thus $NH_4NO_3 = N_2O + 2OH_2$
$\therefore$ 80 of NH_4NO_3 give 44 of N_2O
$\therefore$ 30 gms. of NH_4NO_3 give $\frac{44 \times 30}{80} = 16\frac{1}{2}$ gms. of N_2O
But the specific gravity of N_2O referred to H is 22
$\therefore$ one litre of N_2O at normal temperature and pressure weighs $\cdot0896 \times 22$ grams
$\therefore$ 16 grams of N_2O will occupy $\frac{16\frac{1}{2}}{22 \times \cdot0896}$ litres $= 8\cdot37$.
But if P, V, T, denote the pressure volume and absolute temperature of a given mass of a gas. P', V', T', the corresponding values at any other temperature and pressure, then
$$\frac{P\,V}{T} = \frac{P'\,V'}{T'} \text{ or } V' = \frac{P}{P'} \cdot \frac{V}{1} \cdot \frac{T'}{T}$$
$\therefore$ Volume in the case before us
$$= \frac{760}{740} \times \frac{8\cdot37}{1} \times \frac{288}{273} = 9\cdot06$$

24. MORAY HOUSE.—1. Use *Dr. Smith's* 'History of Greece,' and if you can do so read some of the volumes of 'Grote' relating to the period. 2. Among other books study *Hallam's* 'Constitutional History,' and *May's*, 'Hume' and 'Green' so far as they bear upon your course. 4. *Dr. Smith's* 'History of France,' and other books for special periods. *Freeman's* 'Sketch of European History' would help you to gain a clear view of the modern period of European History.

25. PHILOMEL.—Your papers in the Prize Competition were very well done, and would probably obtain a good pass.

Arithmetic.

1. MAGISTER.—A man invests in a business £2500, paying 25 per cent. profit; at the end of each year he invests his profits in railway shares at par, paying 6 per cent. The business fails after the end of the sixth year, and he loses the whole of his original capital; by how much greater is his present capital, than it would have been if he had invested the whole in railway shares at first, calculating simple interest only?

Capital at the end of 6 years in 1st case:
$= (\frac{1}{4}$ of £2,500 $\times 6) + [6\,\%$ on $\frac{1}{4}$ of £2,500 $\times) 5 + 4 + 3 + 2 + 1]$
$= (£625 \times 6) + (6\,\%$ on £625 $\times 15)$
$= £3750 + (90\,\%$ on £625)
$= £3750 + £562$ 10s.
$= £4312$ 10s.;
Capital at the end of 6 years in 2nd case:
$= £2500 + (6\,\%$ on £2500 $\times 6)$
$= £2500 + (£150 \times 6)$
$= £2500 + £900$
$= £3400$;
$\therefore$ Difference $= £4312$ 10s. $- £3400$
$= £912$ 10s. Ans.

Algebra.

1. FOLKESTONIAN.—Solve:—
$4x^{\frac{3}{4}} - 27x^{\frac{3}{8}} = 40.$
$4x^{\frac{3}{4}} - 27x^{\frac{3}{8}} = 40$
$x^{\frac{3}{4}} - \frac{27}{4}x^{\frac{3}{8}} = 10$
Completing the square.
$$x^{\frac{3}{4}} - \tfrac{27}{4}x^{\frac{3}{8}} + (\tfrac{27}{8})^2 = 10 + \tfrac{729}{64}$$
$$= \frac{640 + 729}{64}$$
$$= \frac{1369}{64}$$
Extracting the square root.
$$x^{\frac{3}{4}} - \tfrac{27}{8} = \pm \tfrac{37}{8}$$
$$x^{\frac{3}{4}} = \pm \tfrac{37}{8} + \tfrac{27}{8}$$
$$= 8, \text{ or } -\tfrac{5}{4}$$
$$\therefore x = (8)^{\frac{4}{3}}, \text{ or } (-\tfrac{5}{4})^{\frac{4}{3}}$$
$$= (2)^4, \text{ or } (-\tfrac{5}{4})^{\frac{4}{3}}$$
$$= 16, \text{ or } (-\tfrac{5}{4})^{\frac{4}{3}}.$$

Owing to the pressure on our space we are compelled to hold over a number of queries, as well as Science Notes, Publications received, Notes of Lesson, Reviews, &c.

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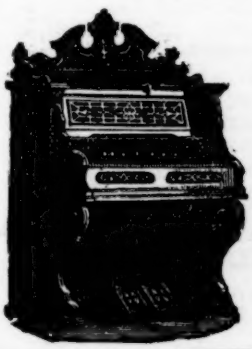

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